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Original Articles

SOME COMMON INDIAN BIRDS.

No. 8. THE PURPLE SUN-BIRD OR HONEY-SUCKER (*ARACHNECHTHRA ASIATICA*).

BY

T. BAINBRIGGE FLETCHER, R.N., F.L.S., F.E.S., F.Z.S.,
Imperial Entomologist;

AND

C. M. INGLIS, M.B.O.U., F.E.S., F.Z.S.

THE Magpie Robin described in our last article is by no means the only bird whose cheery notes enliven our compounds. Conspicuous amongst the smaller feathered songsters and appealing both to eye and ear are the exquisite little Sun-birds or Honey-suckers, of which the males, clothed in metallic colours, are amongst the most beautiful of the birds which occur in India. We have none of those lovely little gems, the Humming-birds, which flash splendidly from flower to flower in South America, but we may almost imagine that we have when we see a tiny bird, clad in the most brilliant purple plumage, hovering over a flower with rapidly vibrant wings and extracting nectar with its long tongue, quite in the manner of a Humming-bird or Hawk-moth. Such a bird is almost sure to be the male of one of our species of Sun-birds belonging to the genus *Arachnechthra*, of which about eight species occur within Indian limits, but of these only three are commonly distributed in the Plains: Loten's Sun-bird (*Arachnechthra lotenia*), which occurs in Ceylon and Southern India, being wholly dark metallic purple

above, with a snuff-brown abdomen and a long curved beak; the Purple Sun-bird (*A. asiatica*), which is found throughout the Plains of India and in Ceylon, but is only a summer visitor to the Punjab, being very similar to the preceding, but with a violet black abdomen and a shorter curved beak; and the Purple-rumped Sun-bird (*A. zeylonica*), which occurs in Ceylon, Southern and Central India, but not in Northern India or Burma, and is distinguished from the other two by its bright yellow lower plumage and crimson back. The females of these three species do not possess the brilliant metallic coloration of their mates and have to be content with a dress which is earthy-brown or greenish-brown above and yellow beneath.

The above-mentioned birds belong, as already stated, to the genus *Arachnechthra*, but we have altogether some twenty-five species of Sun-birds within Indian limits and these are divided into four genera, the largest genus in point of numbers being *Æthopyga*, containing those birds in which the males have lengthened middle tail-feathers and yellow rumps. In this genus the commonest Plains species is the Himalayan Yellow-backed Sun-bird (*Æthopyga seheriæ*), a bird with most of the upper plumage crimson, as is likewise the lower plumage as far as the breast; it also has a purple moustache-like streak and the lengthened tail-feathers are metallic green. This Sun-bird is common in the Plains of North-Eastern Bengal, Assam and Cachar, and is also found along the foot of the Himalayas, which it ascends to a considerable height. It is parasitized in Assam by the Emerald Cuckoo (*Chrysococcyx maculatus*), and we have taken several of this Cuckoo's eggs from the nest of this Sun-bird.

In their habits all the species are very similar, frequenting flowering trees and shrubs, extracting the nectar from the flowers with their long tubular tongues, either occasionally hovering on the wing or more frequently clinging to slender twigs. But, besides carrying out the poet's dictum,

"For he on honey-dew hath fed,"

these little birds variegate their diet with small insects, for catching which their long bills are admirably adapted, both mandibles being

serrated along the terminal third of their length. Small spiders, caterpillars, beetles, bugs and flies, probably in most cases themselves visitors to flowers, fall a prey to these birds. We have also seen the Purple Sun-bird picking insects from off the ground and also flying up and catching them on the wing.

Besides being useful in helping to reduce the numerous insects which haunt our gardens, Sun-birds are also directly beneficial by helping to pollinate many flowers. Writing of *A. zeylonica* in Calcutta, Cunningham says that "the curious narrow tubular flowers of *Hamelia patens* are very special favourites, owing to the large store of nectar in their lower ends; and during the whole time that the shrubs are in flower they are sure to be alive with honey-suckers every morning. In this, and doubtless in many other cases, they seem to play a very important part in securing cross-fertilisation; for, by the help of a field-glass, one can clearly see that every time their bills are withdrawn from one tube and thrust into another, they are thickly smeared with golden pollen; and when flowers from which they have just been feeding are examined, the long oval stigmas will be found coated with adhering grains. In rifling the flowers, therefore, they confer a benefit on the plant, and do not play the part of mere robbers, like the great brown hornets, who share their liking for the nectar, but who, in order to reach it, drill holes through the corollas below the level at which the anthers lie.

"Curiously enough, they do not seem to care for the fluid in the corollas of the silk-cotton trees, which is so attractive to so many other kinds of birds that the trees, when in full bloom, become noisy and riotous taverns thronged with excited topers. The unopened flowers of *Hibiscus rosa-sinensis* are greatly frequented in the early morning on account of some attractive material to be found at the bases of the petals. Erythrinas are also very popular; the clusters of their bright red flowers are very often alive with a throng of clinging and fluttering little thieves; and an even more charming picture presents itself when the latter are busy among the deep green foliage and tufted crimson inflorescence of *Haematocephala Hodgsoni*."

In his volume, *Some Indian Friends and Acquaintances*, Cunningham gives a long and charmingly written account of the habits of *A. zeylonica* in Calcutta, from which we would willingly quote at further length, did space permit, and we can only advise our readers to refer to Chapter XI of his book.

The Purple-rumped Sun-bird is the dominant species in Calcutta, but in Bihar our common species is the Purple Sun-bird, which is depicted in our plate. This is a less sociable bird, more often seen alone and not in company with others, as one sees *A. zeylonica*, but it is a much better songster than the latter, singing much like a canary. The cock bird in the breeding season is a truly gorgeous little creature, appearing a blue-black at a little distance; but when seen at close quarters the colour is a metallic violet-blue or greenish, the colour changing according to the intensity and angle of the light on it so that it may appear shining blackish-purple or green or more often mauve.

"..............ceu nubibus arcus
Mille iacit varios adverso sole colores."

Under the base of his wings he carries a large tuft of mixed orange-red and yellow feathers, which is ordinarily concealed under the wings, but which projects when the bird is settled for repose and is displayed when courting. Like human bipeds, however, the Purple Sun-bird does not wear his wedding garments throughout the year, for after the nesting season is over he doffs them and assumes female plumage, retaining only a dark metallic violet streak from chin to abdomen as a mark of his sex. It may be added that there is a certain amount of difference of opinion as to whether the purple plumage of the male is or is not retained throughout the year, Messrs. Oates and Dewar contending that, when once assumed, it never changes; but Finn, in an article in the *Journal of the Asiatic Society of Bengal* (Vol. LXVII, Part II, No. 1; 1898) settled this question, having noticed the change take place in a specimen which he kept, and which, when he got it, was mostly purple but by the first week of August was in non-breeding dress. We are inclined to agree with Finn as to the change. The female is greenish-brown above, rather bright yellow below with the tail

brown or blackish and the laterals narrowly tipped with white. The male especially is a most pugnacious little creature, not hesitating to attack other birds much larger than himself, and sometimes even scrabbling and tapping at windows, apparently attempting to assault his own reflection in the glass. The breeding season in Bihar is from February to May, the earliest nest taken being on 26th February and the latest on 30th May, and there are generally two or more broods in rapid succession, usually in the same nest. In Northern India, the laying season is later, in May and June, or as late as July or even August. In Southern India, eggs are to be found from January to June, but mostly in February to April. It breeds all over the Plains and to the summits of the Hills in Southern India and up to a height of about 5,000 feet in the Himalayas.

The nest is hung suspended from a twig or any convenient support and is composed of a very miscellaneous and heterogeneous mixture of materials beautifully woven together with the silkiest fibres and cobwebs, hair, fine grass, leaves, small pieces of dead wood, chips of bark, lichens, rags, scraps of paper, thorns, etc., all being made use of. The body of the nest is usually oval, with various scraps of material hanging below, while the apex of the oval is produced into a cone meeting the point of support. The nest is lined with silky-white seed-down, very neatly affixed to the interior. The entrance is a small oval or circular hole, about the centre of the nest, and in some cases, but not always, a small projecting cornice is constructed just above the entrance. On the side opposite to the entrance the wall of the nest, which is ready some days before the eggs are laid, is pushed out a little so as to give room for the tail of the sitting bird. This pushing out of the back of the nest is one of the last portions of the work, and the female may be seen going in and out to try the fit, over and over again. When sitting, the head of the bird is seen just peeping out of the entrance. The completed structure looks like anything but a nest and resembles a mass of dead leaves and rubbish caught in old spider's web. The rows of sticks which support edible and sweet peas in our gardens form a very favourite nesting-site for this bird in North Bihar, as these

sticks are in the ground during February and March, but the nest may be suspended almost anywhere, usually from the end of a branch of a bush or small tree, preferably a thorny one. It is usually placed between two and five feet from the ground but we have seen one as high up as forty feet. The nest shown in our plate, as will be seen, was hung on to a piece of wire netting. Suspended in this way it is tolerably safe from enemies. Two is the normal number of eggs laid, but occasionally there may be three, the eggs measuring about 16 by 11·5 mm., being dull white marked with various shades of brown.

This bird, with other Sun-birds, is protected throughout the whole year in Burma, Bombay and Bengal, and presumably in Mysore also, as it is certainly a "bird of song."

We have kept a specimen of the Purple-rumped Sun-bird in captivity for six months, feeding it on a mixture of sugar and *sattoo.*

Our plate gives a good idea of the Purple Sun-bird and its nest. To the left is seen a male in breeding plumage with its tufts displayed; the female is seen feeding a young bird whose beak is seen projecting from the nest; and below her, to the right, is a male in non-breeding plumage.

THE CO-OPERATIVE MOVEMENT AND POLITICS.

BY

R. B. EWBANK, I.C.S.,

Late Registrar, Co-operative Societies, Bombay Presidency.

THE traditional policy of co-operative societies in England has always been strict neutrality in politics. This tradition was accepted in India during the early years of the movement, and until recently has not been challenged. In 1915, the Committee on Co-operation advised that societies should be prohibited from interfering actively in political controversies, and some local Governments have given effect to their recommendation by a formal rule under the Co-operative Societies Act. This policy has not, however, been unanimously endorsed by co-operators, some of whom maintain that the movement ought not to be isolated from the main stream of public life in India, and that the State cannot at the present stage afford politically to ignore a system which has embraced and organized so many of the best representatives of classes, which are otherwise still disorganized and inarticulate. It has been suggested that the movement as a whole should seek direct representation on the Legislative Councils, either by the reservation of special seats for co-operative nominees or by devoting a portion of its funds and influence to the support of those candidates at the general elections who are pledged to support its special interests. Suggestions have also been thrown out that the privilege of enfranchisement should be extended to all members of the managing committees of efficient societies, or that certain societies of sufficient importance should be empowered to appoint delegates to vote on their behalf at the general elections. It has been urged

that co-operators should seek special representation on local bodies as well as on the Provincial and Imperial Councils. Opinion is deeply divided on these issues, and the leaders of the movement are still groping for principles on which to base their policy and to formulate their aims. The question is one which during the last four years has profoundly stirred co-operators in England, and is at the present moment the crux of a heated controversy amongst them. I have recently had opportunities of discussing it with prominent co-operators in Great Britain, and believe that their experiences in this matter cannot fail to be instructive to their fellow co-operators in India.

It was as far back as the sixties of the last century that English co-operators first burnt their fingers by meddling in politics. The Rochdale Equitable Pioneer Society began the trouble by actively supporting the movement in favour of the suffrage for working men. The Conservative members resented this and started a rival society working in the same area. A third society was founded by a group of independents who rejected alliance with either political party. The split ran right through North Lancashire, and more than a dozen Conservative and independent societies were started. However, the local leaders soon realized the futility of such internecine strife and its inconsistency with co-operative principles. A truce was patched up ; most of the new societies were gradually absorbed by amalgamation ; and neutrality in politics was accepted as an axiom of the movement.

The wisdom of this policy was not seriously challenged until Sir W. Maxwell, speaking as President of the Perth Co-operative Congress in 1897, restated the case for political action powerfully enough to induce the Congress to adopt unanimously the following resolution :—

> "That this Congress feels that the time has arrived for the direct representation of the co-operative movement in Parliament and other councils of the United Kingdom, and instructs the Co-operative Union, with the co-operation of the English and Scottish wholesale societies, to take steps for that purpose."

In accordance with this resolution a joint Parliamentary Committee was formed consisting of 12 representatives, four being elected by each of the bodies indicated. The Committee do not seem to have made any very earnest efforts to secure direct Parliamentary representation; but they kept a keen eye on the proceedings of Parliament, and whenever the interests of the movement seemed to be threatened by any Parliamentary action, they bestirred themselves to interview Ministers and to canvass M.P.'s in favour of the co-operative point of view.

It is not denied that they were often successful in influencing legislation and administrative action, but it is generally believed that they would have exercised far more influence on Parliament, if it had not been well known that the co-operative movement, regarding itself as essentially non-political, wielded no weapon in the form of a vote either inside or outside the House, and would not bite if its bark were disregarded. Its blank cartridges were no match for the powerful artillery of the private trading interests.

At the Paisley Co-operative Congress in 1905, Mr. T. Tweddell, J. P., read a very striking paper advocating direct representation in Parliament. He maintained "that the interests, the freedom, the very existence of the movement depend upon Parliamentary sanction, and are amenable to the influence that Parliament wields; that political action affects us too closely to permit of its being disregarded; that indifference to political consideration is the surest way to invite attack and to court disaster; that co-operation, itself one of the most hopeful forces that aim at social betterment, is imbued with democratic sentiment, is maintaining sympathetic relationships with trades-unionism and other working class combinations, and cannot help being impelled in the direction of political action, for the defence of its interests and the pursuit of its ideals." The deep impression that this able paper was calculated to make was marred by a weak conclusion. After exhorting his hearers to rise to a higher and truer conception of politics divorced from party and regarded simply as a science of human welfare, the reader ended by advising them to cease to be befooled by the existing political parties, to close their ranks as working men, and

to learn the blessed art of acting together, presumably in the bosom of the Labour Party. But the Congress resisted his logic and refused to commit itself to the entire programme of any political party.

The voices within the movement, advocating direct intervention in politics, were about this time strengthened by a new cry raised from outside by certain Labour leaders. The Labour Party felt the need of fortifying their position by an appeal to a wider circle than the small socialist and syndicalist element among the labouring classes, and invented a new slogan which speedily became fashionable—"The Fusion of Forces." This was the name under which a campaign was carried on to persuade the co-operative and trades-union organizations to join forces with the Labour Party and to share a common political platform. There is no room for doubt that the idea appealed to many co-operators, and, as the struggle between capital and labour has become more and more the central point of the political battle ground, round which all political combinations tend to group themselves, a feeling has been growing that the movement cannot remain aloof from a struggle which concerns its first principles so vitally. It was with minds confused and shaken by these new currents of ideas that co-operators entered the great war, and were gradually led, by practical experience of the State control of the necessaries of life, to the conclusion that the great system of production and distribution which they had so laboriously built up might be gravely imperilled, unless they took measures to compel the new Ministers to admit that their claims to recognition and special treatment were at least equal to those of their competitors.

Under the stress of war Government were compelled to introduce methods of rationing the chief necessaries of life on a national scale, and to improvise Ministries, Commissions, and Committees to control their production and distribution. The *personnel* of these controlling bodies was recruited partly from the permanent Civil Service and partly from leading business firms with special experience of the various commodities which were brought under control. At the outset practically no managers or experts connected with the great co-operative factories or distributive stores were offered posts

in the new Ministries. In Germany and France, the service of such men had been eagerly sought by the Government departments concerned, and a suspicion inevitably sprang up that in Great Britain they were being deliberately excluded under the influence of the vested interests, which had for some years shown open hostility to a movement which in 1917 included over $3\frac{1}{2}$ million members, and carried on an annual retail trade amounting to more than £120,000,000. Co-operative societies listened with misgivings to the clamour for a business Government, and feared that it might end in entrenching the great capitalist interests more firmly than ever in their hold on the administrative departments of State. Before long they began to feel that their fears had been well-grounded. They maintain that the recruiting tribunals were influenced to deal more rigorously with the staffs of co-operative shops than of private shops, on the ground that they were not a national necessity and paid no income-tax, and that in consequence of this several of their shops had to be closed down altogether. In one case a warrant was issued by a military officer directing a search of the premises of the Co-operative Wholesale Society, although no other business house in the city was similarly treated. The supply of sugar was confined by the controlling authorities to agencies acting prior to 1914, and they were guaranteed commission at the pre-war rate. This measure seemed designed to protect vested interests and prevented co-operative stores from being as useful to the public as they might have been. In some cases the supply of flour furnished to outside competitors was alleged to be better than that assigned to co-operative stores, with the result that their trade in flour almost disappeared. The supply of wheat to the Scottish Wholesale Society, which claims to be the biggest miller in Scotland, was so unsatisfactory that the miners decided to take an off-day as a protest against the quality of the bread. Similar grievances are mentioned with regard to butter, coal, tea, seeds, petrol and shipping.

The conviction spread that co-operative shops were being victimised in the interests of private traders, and this feeling was reinforced by fears regarding their liability to income-tax and excess

profits tax. Rumours had been set on foot that co-operative societies were undermining and ruining private trade owing to their exemption from income-tax and were evading their fair share of the national burdens. Although Government showed no signs of yielding to this agitation, co-operators felt nervous and thought it advisable to protect themselves by organizing a counter-campaign. In the matter of the excess profits tax they had a real grievance. Although it had been officially admitted by the Exchequer that the dividends paid to their members by co-operative societies were in the nature not of profits but of discount or saving, Mr. McKenna brought co-operative societies within the operation of the excess profits duty, imposed under the Act of December 1915. The policy of treating a co-operative society, except in so far as it dealt with non-members, in the same category as a war profiteer, roused great resentment, and some of the larger societies actually defied Government and refused to pay the tax.

With grievances like these rankling in their minds and with a sense that the many great sacrifices which their societies had undoubtedly made in the cause of the war were not properly appreciated, co-operators met for their annual Congress at Swansea in 1917, and decided that their complaints should be brought to the immediate notice of the Government, and that steps should be taken to secure the representation of co-operators in Parliament. Acting on these resolutions, the Parliamentary Committee submitted to the Prime Minister their considered suggestions on food control, sugar distribution and the use of co-operative organizations by the State, and requested him to receive a deputation. After some delay, they were informed by the Prime Minister's secretary that, owing to his many and pressing engagements, Mr. Lloyd George was quite unable at that time to arrange a meeting with the Parliamentary Committee of the Co-operative Congress. Co-operators were not at the moment in a mood to accept a reply of this sort quietly, and it was decided to convene a Special Co-operative National Emergency Conference at Westminster in October 1917 to consider what should be their next step. The proceedings of this Conference were marked by unusual heat and bitterness.

Resolutions were passed recording indignation at the way in which the Prime Minister had treated British co-operators, and pledging themselves to organize to the fullest extent their political power in order to compel the Government of the day to recognize their special economic position. The Conference emphatically protested against the persistent neglect of Government to use their experience and resources for national purposes and to grant them adequate representation on the new administrative and advisory authorities that had been created. It recorded its conviction that the imposition of the excess profits duty upon co-operators was an absolute negation of justice and called for its immediate repeal. It maintained that it was the intention of the Government again to inquire into the position of co-operative societies with regard to income-tax after the war, and urged all societies to pursue a campaign of opposition to this change with the utmost vigilance. It expressed its strong objection to the constitution of the tribunals under the Military Service Acts, and to the inadequate safeguards against the misuse of their powers. It approved a scheme for bringing about closer unity between the co-operative and trades-union movements, and another scheme for securing co-operative representation in Parliament and on local, municipal, and administrative bodies.

Immediately after the holding of this Conference, the Prime Minister found time to receive the proposed deputation, and in company with the Food Controller, Lord Rhondda, and the Rt. Hon. George Barnes, M.P., gave a very sympathetic hearing to the grievances which they put forward. He brushed aside many of their suspicions of sinister motives on the part of Government as mere hallucinations, and recapitulated the measures which had been taken to secure that representatives of co-operative societies should be placed on the various committees of control. He stated definitely that Government had no intention of bringing co-operative societies under the Income Tax Act, and explained that the excess profits tax, as originally imposed, had recently been modified so as to meet the complaints of co-operators. From the date of that interview onwards the grievances of co-operative societies against the various controls seem to have gradually subsided.

But their determination to seek direct representation in Parliament remained unaltered. At the General Election of December 1918, 10 co-operative candidates stood for election. Only one of these, Mr. A. E. Waterson of Kettering, a local Labour politician, was actually returned. His platform was much the same as that of the official Labour Party ; but the following paragraphs in his manifesto refer specially to co-operation :—

"1. To safeguard effectually the interests of voluntary co-operation, to resist any legislative or administrative inequality which would hamper its progress."

"2. That eventually the processes of production, distribution and exchange (including the land) shall be organized on co-operative lines in the interests of the whole community."

"3. That the profiteering of private speculators and the trading community shall be eliminated by legislative or administrative action."

"4. That in order to facilitate the development of trade, commerce, and manufacture after the war, the Government shall establish a national credit bank to assist local authorities, co-operative societies, and others to finance their new undertakings as required."

Mr. H. J. May, the well-known Secretary of the Parliamentary Committee and himself one of the defeated candidates, explained to me that while members elected on the co-operative ticket were not definitely committed to any party and were willing to enter into any combination which would best serve their purposes, it might be assumed that they would normally work in the closest harmony with the Labour Party.

Whether this venture into the political arena will be permanently maintained by co-operators remains to be seen. Much will probably depend on the issue of the next polls and on the success or failure in the House of their earliest representatives. A strong party within the movement, led by Mr. E. O. Greening, one of the most respected members of the Co-operative Union, are strongly opposed to the departure. They know how few members usually take the trouble to attend annual general meetings (*e.g.*, only about

300 came to the last general meeting of the Woolwich Arsenal Society which comprises more than 80,000 members), and how easy it is for enthusiastic extremists to arm themselves with bundles of proxies and to carry all before them. They already see signs of reaction and point to the fate which has overtaken the Managing Committees of the great Sheffield and Plymouth Societies, who dabbled too freely in politics to please the members and have recently failed to secure re-election. They note that the numbers of societies contributing funds to the political campaign was less in 1919 than in 1918. Now that the friction and inconvenience caused by the various war controls have disappeared, they gravely doubt whether co-operators as a body will think it wise to persist in a policy into which they were stampeded in a fit of exasperation. In the long run these sceptics may prove right ; but my own forecast, based on conversation with such co-operators as I have met and on the articles appearing in the co-operative journals, is that the trend of opinion is on the whole in favour of the new policy, and that it will not be abandoned until it has been given a full trial.

The first point in this history of events, which may be commended to the notice of Indian co-operators, is the persistence with which the policy of neutrality was maintained in spite of the blandishments of both the Liberal and Labour Parties throughout two generations, and the reluctance with which it was finally deserted. Co-operators in Great Britain have never held that they should not proclaim their views and exert their influence on individual political questions. The Sugar Convention, the land system, the Factory Acts, the fiscal question, and education have frequently been discussed at their conferences with vigour and vehemence. But they have always considered that their movement was commercial, social and moral, but essentially not political, and that there were large regions of politics, *e.g.*, foreign, naval and military politics, with which they had no direct concern. To attempt to link their organization to any political party or to adopt a corporate policy regarding the great national issues, in which co-operators as such were not directly interested, seemed to them certain to lead to dissension and to make for the disruption of a movement which was founded

on the principle of common action for specific common objects. They were unable to admit the justice of utilizing funds which had been collected for definite co-operative purposes, in furthering political aims with which a large number of the members were not in sympathy. Their contention was that members, who wished to bring their influence to bear on questions of general politics, should do so in their capacity as private citizens and electors and not as co-operators.

The next point to notice is that they only abandoned their traditional policy under the stimulus of concrete disabilities which were handicapping their business and which they believed themselves unable to remedy without direct political pressure. They were not seeking any preferential treatment for themselves. But they insisted that they were entitled to equality of treatment with other trading agencies, and they suspected that under a democratic Government, which is always more or less susceptible to pressure from outside, they were being covertly attacked by hostile interests plotting to undermine their prosperity. They claim to have gone into politics not as a measure of attack in order to gain further advantages for themselves or to make themselves felt and feared on a larger scale, but as a measure of defence against an insidious attack originated by their enemies.

Lastly, it may be observed that co-operators have concentrated their efforts on securing political power by means of direct representation in Parliament, and that they are practically agreed that their representatives should vote and act with the Labour Party. The corresponding action in India would be the return of co-operative candidates by general district constituencies, since the prospect of Government reserving special seats in the Councils for co-operators is exceedingly remote. In Great Britain co-operation has developed as a great consumers' movement, and is composed mainly of industrial employees who have united in order to cheapen the necessaries of life and make their wages go further. It comprises for the most part a single class with more or less uniform political ideals. Their congresses consist only of delegates of this class, and no longer find room for individual sympathisers from the

upper classes of the type of Vansittart Neale. In India the movement embraces three distinct classes : the producers, including all agriculturalists ; the consumers, consisting mainly of the industrial populace ; and the bourgeoisie, represented, for example, by the great caste societies and the central banks as at present constituted. It is not yet clear what party divisions will manifest themselves in the new Legislative Councils, nor whether it will be possible for elements so diverse as those taking part in co-operative work to agree on a common political programme. Any movement to ally the organization to any particular political party would probably give rise to acuter differences of opinion in India than in England.

The question whether co-operators should take part in politics has been treated in this paper as a co-operative and not as a political problem. If Government, in lack of any other constituency representing the labouring classes, were to invite co-operators as such to accept some form of enfranchisement, that would create an entirely new situation. But as matters stand at present, the British example seems to teach that co-operators should hesitate to abandon political neutrality until they are driven to it by definite grievances arising from political or administrative action, and until they are sure that the representations submitted by them to the proper authorities are not being dealt with on their merits.

In India societies occupy at present a distinctly privileged position under the special protection of Government. They have much to lose and it behoves them to tread delicately. At the same time on particular political questions, especially those in which their own interests are directly affected, it seems clear that they have a right to make themselves heard and that their views might be of great value both to Government and the public. It would probably be inadvisable, for the sake of securing their general neutrality on the wider issues of party politics, to debar individual societies, or any organization capable of representing the movement as a whole, from discussing such questions and placing their considered conclusions before Government, the Legislative Councils, or the public.

THE IMPROVEMENT OF AGRICULTURE IN BIHAR.*

BY

A. C. DOBBS, B.A.,

Director of Agriculture, Bihar and Orissa.

HAVING been asked to contribute a paper to this Conference, I should like to advocate the study of agriculture by Bihari students, when their more academic studies are over, not necessarily as a profession, but at any rate as a subject about which it is essential that the educated youth of Bihar, on whose judgment as voters so much responsibility will shortly be thrown, should think deeply in proportion to its importance.

On that importance it is hardly necessary to insist. It has been brought home to us all by the increased prices of food grains and of cotton cloth, due partly to the extensive failure of crops in 1918, and partly to the exposure by the realities of war of the artificial nature of the value attached to the precious metals in which contracts other than those relating to agriculture are usually discharged. The rupee does not buy half as much as it did, and the agriculturist whose income is not measured in rupees has some compensation for an occasional crop failure.

I hope, therefore, to be able to enlist the interest of at least some of those present who no doubt intend to be Bachelors and Masters of Arts, in this aspect of agriculture—as an art which every educated man who draws income from land should study.

Agriculture is indeed one of the oldest of the arts, and, if we extend the meaning of the word to include the whole art of reaping Nature's harvest of food, it is the oldest art of all.

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* A paper read at the Fifteenth Bihari Students' Conference held in October 1920.

And in this fact lies the explanation of one of the most disconcerting and difficult problems with which those who try to improve agriculture are faced. For, being based on an inherited tradition, almost amounting to instinct, of the uses of the natural resources of each locality for the production of food, and on a compelling interest in the bare maintenance of life, the art of merely producing food can be carried on with the minimum of material equipment and with the greatest possible economy by an indigenous agricultural population on the borderline of starvation. An outsider attempting to grow the same products with hired labour is not competing on equal terms, and almost invariably fails to make agriculture pay. He has a less intimate knowledge of the plants and animals that he is dealing with and of the effects of soil and climate on them, and the labourers he employs have no direct interest in the results of their labour ; they will, in fact, where land is plentiful, commonly work for hire only after finishing the necessary minimum of work on their own land.

In a country of labouring cultivators we are, therefore, confronted with the initial problem that the greater the skill of the cultivator and the better his practice in the matter of using good seed, manure and implements, the more difficult it is to make agriculture pay for the application of outside intelligence, and the more immediately costly becomes any indulgence of the natural desire of many educated men to " take up " agriculture. It is only by the introduction of new factors beyond the scope of the labouring cultivator that an outsider can hope to make agriculture pay ; and to do this on the scale necessary to make what an educated man considers a decent living involves the risk of a considerable amount of capital.

The work of agricultural improvement, therefore, falls into two distinct and almost opposed branches : firstly, the discovery of more economical seeds, manures, and implements for the man who works on his own land—which may be called purely philanthropic work ; and, secondly, the elaboration of profitable systems of utilizing any peculiar local advantages, by the introduction of new factors beyond the control of the labouring cultivator. And while the Agricultural Department's work has been chiefly along the former line, it is the

latter to which I wish to direct the particular attention of Bihari students.

Apart from the few retired business men who take up agriculture as a hobby, and are unlikely to make it pay unless they can find some existing model to copy, it may, I think, be assumed that most of the educated men who are interested in agriculture, among whom I hope many of those at this Conference may be included, are, or will be, landowners on a larger or smaller scale, who have an annual income from land, and possibly some outside capital. The control of this income or capital is the most obvious outside factor which, if, but only if, skilfully used, on a carefully planned and tested system, should enable any of you to improve the agriculture of your locality.

Instances of such systems of agricultural improvement by judicious expenditure will occur to all of you. Perhaps, the most important, at any rate in South Bihar, is the system of 'pines' and 'ahars' by which enormous areas are protected against the effect of a shortage of rain at this season. The reward of such permanent capital improvements is, however, for the most part reaped in the form of increased rent; I can think of no improvement in system, introduced by Bihari landowners, which produces increased profits on working capital,—as, for instance, the use of larger bullocks with suitable implements, such as are used on Government farms, which enables a man to do two or three times as much work in a day without necessarily increasing his wages. The breeding of larger cattle and the use of larger implements is one of the directions in which a solution may be sought of the problem of making agriculture pay for increased attention on the part of educated men. There are many others, but they all have this in common, that it requires a considerable amount of initial experimental work based on a knowledge of the local conditions to develop a new system to the point at which it can be profitably adopted on a large scale.

On the other hand, the ultimate profit may be very great. The Agricultural Department has, for instance, shown that it is possible, by a combination of drainage in the monsoon with the ordinary irrigation of sugarcane at other seasons, to produce 6,400 lb. of *gur* per acre, on a large scale at comparatively little more expense

than is usually incurred in the production of one-third of this quantity. Drainage is not always possible in Bihar, but there are large areas in South Bihar where there should be no difficulty. This again is only an instance. What I should like to impress on this Conference is that the way to any considerable improvement in the agriculture of Bihar lies through the direct application of intelligence to agriculture and horticulture on a small scale by educated men who have the opportunity to study the art on their own land without any immediate necessity of making a profit. It is not only unnecessary, but impossible, to learn agriculture at a school or college ; each man must study it for himself on his own land. On the other hand, science can give a good deal of help, and the Agricultural Department, though unfortunately unable at present, owing to a partial suspension of its work during the war, to give very much practical assistance, can always make suggestions for experiments which, if not always successful under new conditions, will at any rate prove interesting and instructive ; and which may point the way to simple improvements adapted to the locality, which can be worked out on a small scale at comparatively small cost, and the adoption of which on a large scale may bring copious reward for the small amount of drudgery incidental to what is after all, to those who love the ever changing face of Nature, a most interesting and fascinating study.

If then any of those Biharis, who may, perhaps hitherto, have regarded themselves as only temporarily students, are prepared to continue their studies on their own land at home, I hope they will get into touch with the Agricultural Department which is always prepared to help, to the best of its ability, those who are actually superintending the cultivation of their own land.

A NEW SOIL SAMPLER.

BY

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AND

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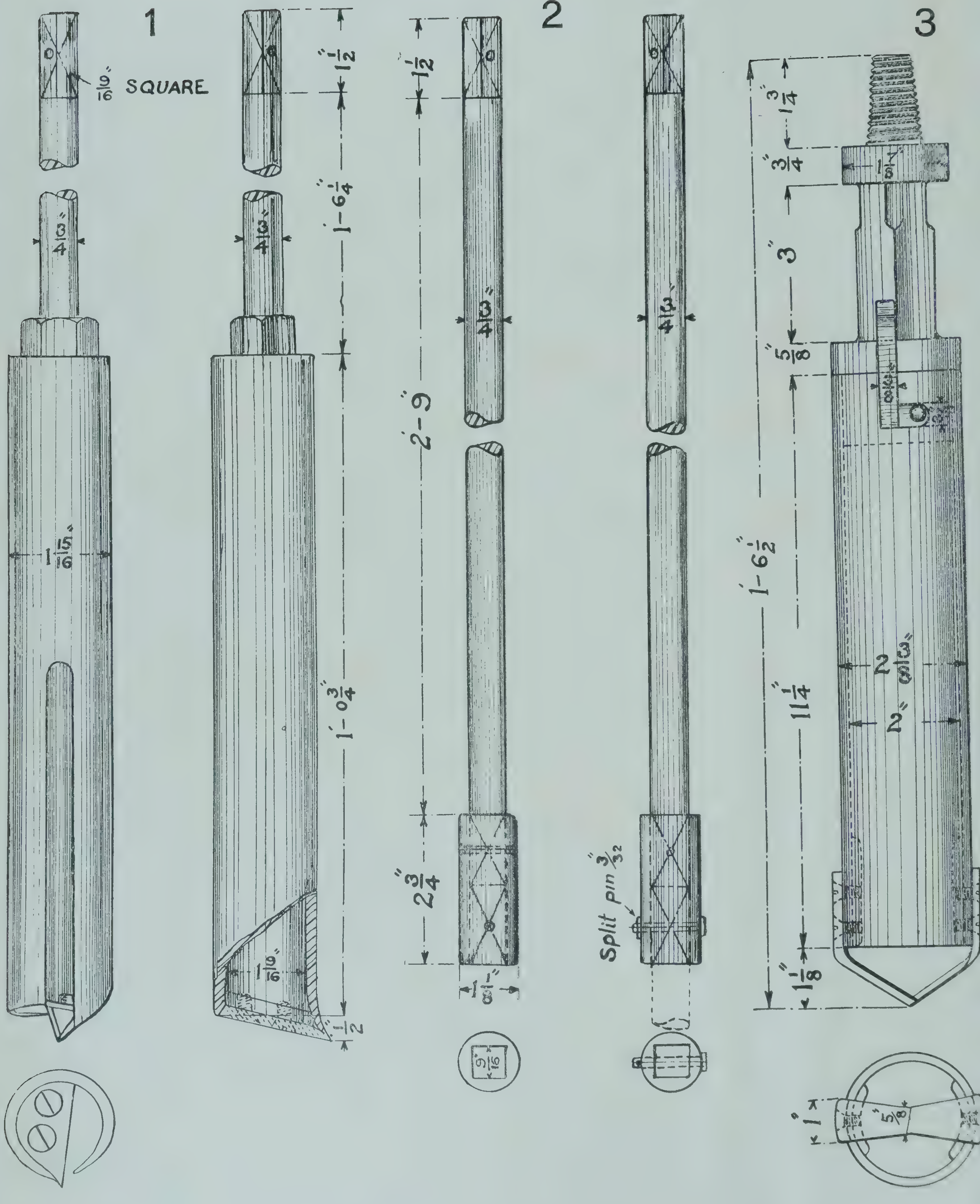
For the analysis of soil and the investigation of its moisture content, one of the greatest difficulties is to obtain a truly representative sample of the soil under investigation. A great variety of instruments has been described and some are in the market. The success which has been met with in a type which has been evolved at Lyallpur (Plate X), mainly with the object of taking deep samples for moisture investigations, together with the fact that it can be easily made by any intelligent *mistri*, leads us to give a description of it in the hope that it will prove useful to other workers. The main advantages which have been gained by the use of this instrument are—

(1) the rapidity of working,
(2) ease by which sampling may be pushed to a depth of as great as 12 feet,
(3) the fact that it is equally efficient in light sandy soil and the hardest clays, and
(4) the fact that no heating of the soil sample, due to grinding, takes place, which would cause an error in moisture determinations.

The drawings reproduced in Plates XI and XII will make any lengthy description of the instrument unnecessary. The auger can, of course, be made of any suitable size, preferably of steel. At the

A NEW SOIL SAMPLER.



A NEW SOIL SAMPLER.

mouth of the auger, a blade is placed in an oblique position which slightly projects beyond the diameter of the tube. The blade is removable and can consequently be sharpened. The advisability of allowing a slight projection of the cutting knife has been found in the fact that the hole so cut being larger than the diameter of the tube presents no difficulties in reinserting the auger after removing the sample. A slot is cut in the side of the tube, and this allows of the removal of a heavy soil by means of a spatula.

Fig. 1 on Plate XII shows a weight which can be placed at the top of the boring rod when difficulty is experienced in driving an auger through a very hard soil. It may be mentioned that it is very infrequently, and only at considerable depths, that there is any necessity to use this attachment.

Plate XII, fig. 2 shows details of a board which has been found advisable to use in deep borings, the object of which is to keep the direction truly vertical. The board is pegged down to the soil by four large iron pegs; by means of sliding shutters, the boring rod is enclosed by a bearing collar which will keep the rod perfectly straight.

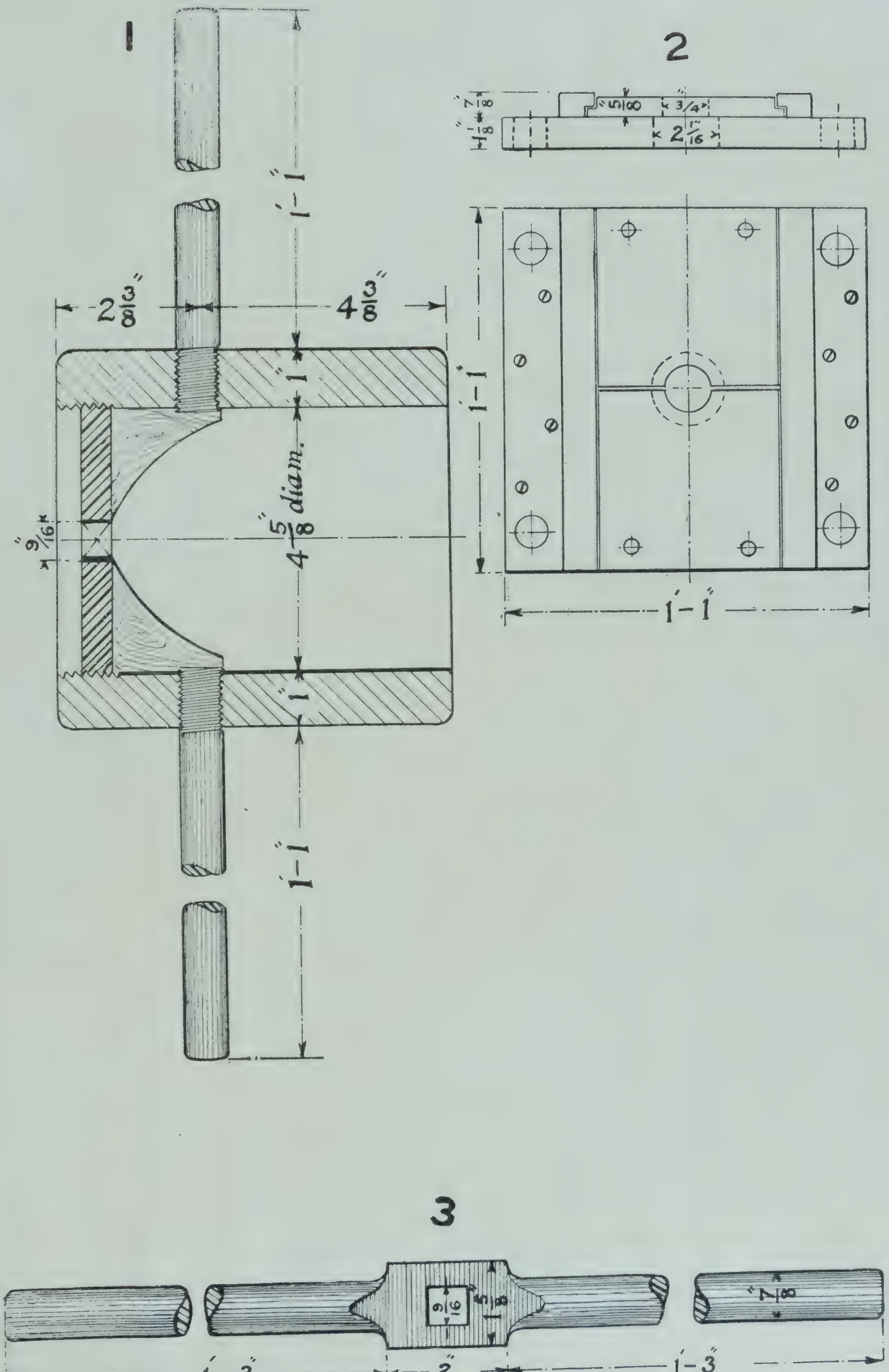
With this instrument for ordinary surface sampling, *i.e.*, 1st and 2nd 9 inches of the soil, it is an easy matter to take as many as 250 samples in dry soil spread over an area of 25 acres in a working day of eight hours with only a pair of labourers. This is a tremendous improvement on the performance which can be got with the borer described by Leather (*Memoirs of the Department of Agriculture in India, Chemical Series*, Vol. I, Nos. 6 and 10), which is still in use in many parts of India. As an example of work under the most difficult conditions, it may be mentioned that it was found possible to sample to a depth of 11 feet in six separate places in the very hard soil met with at the Ganji Bar Experimental Station and spaced over an area of more than a square mile. This was done with the help of four labourers in an eight-hour day. The most unintelligent labourer can be trained to use the instrument in a space of about half an hour.

In connection with the work on the movement of soil moisture which is being conducted at Lyallpur, it has been found that the

experimental error involved in moisture determinations of samples derived from vertical borings is very considerable. A method has consequently been perfected by which horizontal samples are taken from an observation well. The observation well is cheaply constructed by lining a *katcha* well with a trellis of bamboo which is kept in place by wooden braces. For the purpose of taking samples, the sampling tool was somewhat modified.

Fig. 3 on Plate XI shows the cutting tool. It is composed of a steel tube on which is rivetted a knife edge bent into the shape of a V. The tube can be fitted on to the socket by means of a slot and pin attachment, and is securely locked in place by means of a spring. The tool is then affixed by means of a conical thread to a ratchet drill which is placed diagonally across the well. By this means it is possible to take samples every 6 inches to a distance of 6 feet from the side of the well in the space of about three hours. After a distance of about a foot and a half, it is found that the moisture content of the samples becomes constant to within about 2·5 per cent. on the total moisture content. The following table shows the actual results obtained in one such boring which was made in a direction parallel to an irrigation channel and at a distance of about 8 feet from it. The error involved includes errors due to lack of uniformity in the soil and irregularity in the cross-section of the channel.

Depth	Moisture content	Deviation from mean
0″–6″	11·70	....
6″–12″	12·02	....
1′ 0″–1′ 6″	12·22	0·31
1′ 6″–2′ 0″	12·08	0·45
2′ 0″–2′ 6″	12·17	0·36
2′ 6″–3′ 0″	12·38	0·15
3′ 0″–3′ 6″	12·45	0·08
3′ 6″–4′ 0″	13·04	0·51
4′ 0″–4′ 6″	12·27	0·26
4′ 6″–5′ 0″	12·67	0·14
5′ 0″–5′ 6″	12·87	0·34
5′ 6″–6′ 0″	13·14	0·61
Mean ..	12·53	0·321
VARIATION PER CENT. ..	..	2·5



A NEW SOIL SAMPLER.

This method, therefore, allows of an accurate determination of the moisture content of the soil in a horizontal stratum at any depth which can be attained by the observation well. The cost of the ordinary borer first described is not more than Rs. 25. The weight of the borer excluding the weight, which is only seldom used for deep borings, is only $12\frac{1}{2}$ seers.

EXPERIMENTS WITH CASTOR SEED CONDUCTED AT SABOUR.

BY

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THE importance of all oils has been greatly emphasized during the late war. Of all vegetable oils castor oil is perhaps the one the demand for which is most likely to increase. Originally used as an illuminant in the days before the introduction of the mineral oils, its use has now completely changed to that of one of the most valuable lubricants known. Attempts have therefore been made to determine whether by chemical selection it is possible to improve the race of castor from the point of view of its oil-yielding properties.

The main difficulty in the way of such a selection appeared to lie in the fact that the castor plant, with its separate male and female flowers, was much more likely to be subject to cross-fertilization than a plant whose flowers were hermaphrodite. In consequence the investigation, although it had appealed to the writer for many years, was left alone, as being probably of only academic value. In 1918, however, an article appeared in the *Journal of Heredity* (Vol. IX (1918), p. 198) in which it was stated that, contrary to expectation, castor plants grown in America had not been found very subject to cross-fertilization. In consequence an attempt was made to survey the different types obtained from various parts of Bihar. A number of types were sent in by different district inspectors, and were examined for oil-content in the writer's laboratory after drying. Remarkable differences in oil-content on seed were observed from these different types, of

which 75 were isolated from seed characters, by courtesy of the Assistant Economic Botanist, Mr. A. C. Ghosh. This oil-content, as estimated by ether extraction, varied from as low as 21·8 per cent. to as high as 58·8 per cent. on the whole seed. Such differences appeared very striking, and selections were made and planted of seeds of very low and of very high oil-content. Of the 'low' collections, no type had an oil-content of more than 40 per cent. and the average of 14 selections was 32·9 per cent. oil on seed. Of the 'high' collections, no type contained under 50 per cent. of oil and the average oil-content of 13 selections was 52·8 per cent. These types on growing were found to be very impure. This was only to be expected as the crops have never been grown with any attempt to keep different varieties separate. It was, however, to be expected that the first generations of plants from seed with oil-content as widely varying as the above would also, on the average, show very large divergences which, even if they were less than those of their parents, would still be very large. Of these selections only 12 of each kind, 'high' and 'low,' actually grew, whilst actually the average oil-content of the seed of plants from 'high' seed was 49·3 per cent., and that of seed from 'low' seed was 50·6 per cent. Results such as these could not be expected to have occurred as a result of cross-fertilization, nor to have been due to mixed varieties, and it was assumed that the great differences, originally observed in oil-content in the seed of these varieties, may have been observed owing to the different conditions under which the plants were grown. At any rate it is obvious that selection of seeds at random from different localities, in which the seed may have been grown under very different conditions, is not likely to be of much use.

Fresh selections were therefore made from the highest and lowest yielders of the 1919 crop. In this crop, the plots of which were grown under uniform conditions at Sabour, the differences between high and low yielders were not so great. Fifteen parents of low oil-content were taken and twenty of high oil-content. Of the descendants of the fifteen 'low' plants only 10 plots showed good growth. It would therefore be better to consider only these ten,

as it is possible that the state of growth of the plant may have an effect on the oil-content of the seed. Nine of the twenty 'high' plots should probably also be eliminated, as they were badly affected by insect attack, and, in consequence, the flowers and seed were probably abnormal. In fact, the amount of seed produced was very small, and in every case showed an oil-content below the average. The mean of the 11 good plots was 49·6 per cent. for descendants of parents whose mean was 54·2 per cent. The mean of the 10 well grown 'low' plots was 48·6 per cent. from parents whose mean was 42·5 per cent.

These results were found to differ very little from those obtained by taking the mean of all the plots, whether well or ill grown. In this case the mean of the 20 'high' parents was 54·8 per cent. and of their descendants 47·8 per cent. The mean of the 15 'low' parents was 44·1 per cent. and of their descendants 47·3 per cent. There appear, therefore, to be strong indications that in the majority of cases the plants do not transmit a high or low oil-content for even one generation, but that both 'high' and 'low' seeds give plants which, in nearly every case, give a seed near the mean oil-content, which lies somewhere close to 49 per cent. when the plants are healthy, and a little lower when the reverse is the case. It will be seen moreover that the inclusion of the unhealthy plots has in each case, as was to be expected, lowered the mean oil-content of seed observed. Out of the whole series, however, two appear to have kept pure as regards high oil-content for more than one generation. This will be shown by the following table :—

Plot No.	Original analysis	1st generation	2nd generation	Weight of seed in ounces
26/19	51·9	52·4 green	3 distinct varieties each high in oil—	
			Green .. 50·0	28
			Purple A .. 50·4	10
			,, B .. 51·3	¼
34/19	58·8	57·0 dull purple	Two distinct varieties—	
			Purple A .. 52·8	15
			Purplish green B .. 52·8	22½

In addition, a plot has been observed which shows a splitting-up into different varieties which differ in oil-yielding as well as in ordinary botanical characters. This is shown by the following table :—

Plot No.	Original analysis	1st generation	2nd generation	Weight of seed in ounces
75/19	54·7	54·9 green	Four distinct varieties—	
			Green A .. 51·8	4
			,, B .. 50·6	12
			Purple A .. 46·6	½
			,, B .. 50·4	½

It will be noted that in this last instance the low-yielding variety is only present in very small quantity, and may possibly be due to a first cross as the original parent was green. Observations on these three varieties will be continued.

The method used in these analyses was that of extraction of the dried seed with ether. This method, naturally, shows a higher percentage of oil than could possibly be obtained by the oil-presses used in this country. The results, however, may be taken to give a good comparison between different varieties, and give a good idea of what could be obtained commercially by the modern method of extraction by solvents such as petroleum ether or carbon tetrachloride. There were great practical difficulties in the way of extraction of more than a small quantity of seed, and in consequence it is necessary to examine how such a small sample will indicate the composition of the main bulk. For this purpose a number of samples of seed obtained from botanically pure, or nearly pure, varieties of *bhadoi* castor were kindly placed at my disposal by Mr. A. C. Ghosh, Assistant Economic Botanist. The analysis of 15 samples from a bulk collection of one variety showed last year a standard deviation, from the mean, of ± 1·04 per cent., the mean being 49·5 per cent. Other analyses have been made this year, taking selections from plant to plant in each of these fairly pure varieties, and such analyses in each case show a standard deviation, from the mean of the series, of about ± 1·5 per cent., th emean varying from 47·6 per cent. in the lowest case to 50·9 per cent. in the highest. From these

observations we may calculate that the probable error in the oil determination of a single sample of any one variety will be about $\pm 1 \cdot 0$ per cent. of the weight of the seed. This is the case when the crop is fairly evenly grown, and when the seeds appear to be properly filled out. Greater variations have been found to occur in a crop of seed which does not appear to be fully developed. As an example of the differences in magnitude of the variations which occur in a pure crop which is grown under different conditions, we may take a castor which was selected both for field characters and oil-content in 1918. This variety was isolated among others at Sabour by the Professor of Agriculture, Mr. S. N. Sil, and was finally selected as the result of analysis in the writer's laboratory. The original analysis of this variety, known as *pachka*, showed an oil-content on whole seed of 52·1 per cent. in 1918. The variety has been continued in 1919 and on to this season. A single analysis was done on this variety sown both in the *rabi* and *bhadoi* seasons. The *bhadoi* sample, which gave better developed seeds than the *rabi* grown plant, showed an oil-content of 56·2 per cent. of oil on seed, and the *rabi* sample showed 53·6 per cent. The variety therefore appeared to be keeping up its reputation for high oil yield, and in consequence ten samples were analysed of the seed grown in the *rabi* and *bhadoi* seasons, respectively. The *rabi* grown crop showed a mean of 52·3 per cent. with a standard deviation of $\pm$ 2·0 per cent., while the *bhadoi* grown crop showed an extraordinary evenness in the samples. The mean of the ten samples of this latter was 54·4 per cent. and the standard deviation only $\pm 0 \cdot 7$ per cent. As has been already mentioned, the *bhadoi* sown seeds gave a far better developed crop of seed than those sown in the *rabi* season, and it is probable, from the large standard deviation observed in the latter, that the effect of different conditions of growth may be strongly marked in the seed obtained from each plant. Reference has already been made above to the possibility of this phenomenon, and this result would appear to confirm this reasonable expectation. It would, moreover, almost appear from the above results that variations in agricultural treatment may possibly have more effect on the oil-yield of the crop than actual chemical selection. As the

result, therefore, of a considerable amount of work, a few varieties have been selected which appear to be richer in oil than others, and which maintain a mean oil-content greater than 49·5 per cent. which may be taken as the mean of all the types tested here. The improvement, however, is not as marked as was hoped, the greatest improvement observed above the general mean this year being just under 5 per cent. in the case of the *bhadoi pachka*, while the *rabi pachka* only showed an improvement of about 3 per cent.

A NOTE ON THE IMPORTANCE OF THE GENUS "HABRONEMA" AS AN ECONOMIC FACTOR AMONGST THE EQUIDÆ OF THE PUNJAB AND THE NORTH-WEST FRONTIER PROVINCE.

BY

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IN Fleming's translation of Neumann's Parasitology, "Spiroptera" or, to give them their more modern name, "Habronema" are stated to have slight, if any, pathogenic significance. Anyone who has had experience of the condition and has seen the large suppurating tumours produced by *H. Megastoma* in the pyloric region of the stomach, and the occasional ulceration, inflammation and congestion caused by *H. Muscæ* and *H. Microstoma* in the cardiac portions of that organ, knows that this statement is utterly at variance with the facts of the case.

This disease in recent years has received a certain amount of attention in Australia and America, and is rightly blamed as being the cause of much loss in both countries.

During the past year the writer has had many opportunities of examining the stomachs of horses and mules which have been destroyed for chronic debility from various Stations and Remount Depôts in the Punjab and the North-West Frontier Province.

In every case the stomach was the seat of serious lesions due to the ravages of one or all species of the *Habronema.*

In one case the writer was asked to give his opinion as to the persistent debility shown by a batch of fifty Tibetan mules. The R. A. V. C. authorities concerned kindly placed several old debilitated cases at his disposal. Post-mortems proved that in every case the condition was due to Habronemiasis.

The condition may be recognized by the tumours of various sizes in the case of *H. Megastoma*, and by the large numbers of tiny thread-like worms lying on the mucous membrane of the cardiac portion of the stomach in the case of *H. Muscæ* and *H. Microstoma*.

These are more easily seen if the ingesta is removed from the stomach and the organ placed in a vessel of water, when the parasites can be readily seen floating throughout the liquid.

The life-history of the parasites has been worked out by Bull, Van Sacegham and others, and is briefly as follows :—

The eggs produced by the female *Habronema* pass out in the fæces and are ingested by the fly maggot. These eventually make their way to the thorax and proboscis of the mature fly, and it is supposed that the horse, by ingesting infected flies either in his food or drinking water, infects himself, and thus completes the cycle. *H. Muscæ* and *H. Megastoma* have as their intermediate host the common house fly—*Musca domestica*, whilst *H. Microstoma* develops in the stable fly—*Stomoxys irritans.*

The fly can only become infected as a larva, not as a nymph.

The adult *H. Megastoma* is found enclosed in tumours and seems for preference to select as a site the pyloric portion of the stomach although the lesions may be found in any part of the organ.

These tumours are generally conical in shape and vary in size from that of a small pea to that of a hen's egg. The tumour is usually full of hard inspissated pus, and a number of worms can generally be seen protruding from a small opening at the apex of the cone and waving in the lumen of the stomach. In some cases there is no opening. It can readily be understood that the portion of the stomach thus affected ceases to function. This species is the most harmful of the *Habronema.*

H. Microstoma and *H. Muscæ* lie loose on the mucous membrane of the cardiac portion of the stomach, and may cause an acute

inflammation and congestion. They do not seem to affect the pyloric portion of the organ. *H. Muscæ* is probably the least harmful of the three species.

Lewis and Seddon, Bull and Van Sacegham have proved that the disease known as "Habronemic Granuloma" is caused by the larvæ of these parasites, *H. Microstoma,* in all probability, being the species chiefly concerned. The condition known in India as "Bursatee", and believed by Lingard to be due to Filariasis, is probably due to the larvæ of the *Habronema.* When one considers the fly population of India and the construction and sanitation of the lines and stables of the various Army Units and Breeding Studs, but more so of the civilian population, and the opportunities thus afforded for the spread of any disease from manure in which the fly is likely to act as a carrier, it is quite obvious that Habronemiasis is likely to be responsible for many, if not most, of the chronic cases of debility which must annually cost the Army and the country very large sums of money. Add "Habronemic Granuloma" (Bursatee) and "Habronemic Conjunctivitis", and the importance of the prevention and eradication of this all too often unrecognized condition is at once evident.

Prevention. Eradication of flies as far as possible, thorough cleanliness and strict sanitation as regards manure are the essentials. There are various methods for dealing with manure. Robaud's method, *i.e.*, burying the fresh dung daily inside a heap of fermenting manure and thus destroying the larvæ of the *Habronema* and the fly maggot, is probably the most simple. However, that is a point that can best be decided by the authorities concerned.

The early isolation of all debility cases, thorough destruction of the excreta when possible, and dosage with a reliable vermifuge (*see* treatment) should be insisted upon as a routine measure.

Treatment. The work of Maurice Hall and others has shown the great value of *Ol. chenopodii* as a vermifuge. This drug either alone or in conjunction with chloroform, followed by linseed oil and turpentine, might be tried with advantage.

It should prove efficient against *H. Muscæ* and *H. Microstoma,* and it might be effective against *H. Megastoma.* Carbon bisulphide

whose value as an anti-bot agent has been recognized for years, also strikes one as being a suitable drug to try. Van Sacegham regards the destruction of the *Habronema* in the stomach as the ideal preventive measure against summer sores, arsenic up to 2 grains per diem being recommended.

His method of curative treatment for summer sores is as follows :—

Disinfect the sore thoroughly and then apply the following :—

Plaster of Paris	100
Alum	20
Naphthalene	10
Quinine	10

This rapidly dries the sore, prevents the attack of flies and prevents the animal biting itself. He regards it as a specific.

In conclusion, the writer would draw attention to the necessity for careful post-mortems on all debility cases, as it is comparatively easy to overlook the presence of these minute worms, more epecially *H. Muscæ* and *H. Microstoma.*

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SOME RICE-BREEDING EXPERIENCES

BY

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Introduction.

This paper is an attempt at placing on record some of the many experiences peculiar to rice-breeding on Mendelian lines. These relate to swamp rice and have been gained in the course of seven years of breeding work on rice mainly at the Paddy-breeding Station, Coimbatore, and secondarily in the Tanjore delta farm at Manganallur. No attempt is made to traverse the familiar field of paddy agriculture, nor to supplement in any way the scientific aspects of the work, the first instalment of which has appeared as a Pusa Memoir.[1] This article has been written in the hope that it may be of some little practical help to beginners in the same field, and also to stimulate an inflow of similar experience from other quarters, to the eventual benefit of all.

The work.

Work on this crop is very difficult and trying, but the wealth of scientific material and the enormous economic possibilities easily provide the inspiration. Paddy work is work in puddle. Going about it with boots on is out of the question, the work being so intensive that the huge lumps of mud, getting lifted with each move, play havoc in the family of plants. Bare legs are thus a necessity, and clean *bunds* and scrupulous field sanitation are hence quite essential. To work under these conditions both fore- and after- noon is a physical impossibility and, therefore, puddle work is

[1] Parnell, Rangaswami Ayyangar and Ramiah. "The Inheritance of Characters in Rice, I." *Memoirs of the Department of Agriculture in India, Botanical Series*, Vol. IX, No. 2.

confined to forenoons only. The afternoons, when spent in the fields, are best done comfortably with dry feet, quietly walking along the *bunds* and drinking in the general impressions of the various plant groups. I would strongly advocate the most thorough and intimate touch with the plants handled, be it counting the number of tillers, marking the flowering dates, measuring the heights, or noting the more detailed characters incidental to the intensive study of one and the same crop. There are not always big, broad and patent differences. Everything, however minute and insignificant, counts. It was a pleasant surprise to have noticed that what passed for two identical varieties of paddy proved to have had their only difference in the colouring of the tiny little downy growths from which the pedicle of the spikelet originates. So also with the operations. Nothing is trivial, nothing to be lightly brushed aside—vigilant care at every step. I am strongly in favour of every breeder going personally through each unit of experience so that, in the fulness of intimate knowledge, he can safely guide the various human units contributing to the common work. Another point of great importance is to manage to spend as much of one's time as possible among the plants. The more one moves among them, the more does one get to know them. There is always some revelation in store.

THE PLOTS.

An intimate touch with the whole of the farm area is an essential requisite of all breeding work. The oddities of every nook and corner should be known. With this intimacy, the correct block of plots should be chosen, suited to each group in the cropping. There should be plenty of *bunds*—all being parallel either way. The main *bunds*, marking each distinct drop in the general contour of the area, should be at least three feet wide, the subsidiary ones being eighteen inches. The channels are to vary from one to two feet in width according to their location. Of these, too, it is desirable to have as many as possible, in view of each channel combining both the irrigation and drainage of the fields below and above it. The irrigation water should be let in at one corner of the field, run across it, and let out at the corresponding diagonal corner. This

minimizes the effects of the fresh current of silt-laden water, in its possibilities of inducing uneven growth. Close after the letting in of water puddling commences, and water is allowed to stand in the fields. Now is employed what the station calls a "scum boy," whose business it is to be continually removing the floating scum and debris from the corners of the fields to which these get blown during high winds. This removal, if vigilantly done, reduces considerably the extra fertility and delayed ripening which are a common feature of the crop in all such corners. Another local disturber is the dung of the ploughing and levelling cattle, the prompt removal of which is essential to uniformity.

Seedbeds and sowing.

Paddy seeds have to be soaked in water, drained, sprouted and then sown. Soaking, in the case of single plants, is best done in the wide-mouthed, tin screw-top bottles in which the seeds are stored. The naphthalene balls put in against insects should be removed. The paraffined label emerges through the soaking safe and sound. The tin screw-top gives security, and the wide mouth is an obvious convenience for the easy pouring out of the seed. The draining is done by placing a wire mesh over the mouth and gently inverting the bottle. This takes out almost all the water, and what little is left is drained thoroughly by repeating the process over a piece of fourfold blotting paper and letting the bottle remain inverted for about ten minutes. The next step is to pack the seed mass at the bottom of the bottle, pushing down the seeds sticking to the sides. This over, the bottles are arranged in a box which is left covered with a wet gunny bag. The next day the seeds sprout and are ready for sowing. They are emptied into the palm of the hand and sown. What remains at the bottom or sticking to the sides of the bottle is brought together by taking in a little water from the channel, giving it a sharp twirl and briskly pouring the contents out into the palm, when it will invariably be found that the bottles remain absolutely emptied. Paddy up to half a pound is easily soaked in wide-mouthed bottles, and for larger quantities muslin bags have to be used in the ordinary way, one for each unit

of about 3 to 4 lb. Drill bags have proved unsatisfactory, being close-meshed and hence difficult to drain properly.

Seedbeds for single plants are made in strips three feet wide and as long as the size and quantity of seeds sown. The big range of variation which makes it possible for over 10,000 seeds of *Jeeraga Samba* to be in a four-ounce bottle which would take in only about 3,500 seeds of the big *Kallundai*, shows the need for adjustments suited to the variety. But it will be found with a little experience that the budgetting of sowing room is a comparatively easy matter. Three feet is a convenient width for a range ensuring even-sowing from one side of the plot—the row of plots contiguous to it between two channels, standing in the way of getting at each individual plot from both sides. In the case of bulk sowings, strips, six feet wide and running the whole width of each big plot, afford a convenient breadth for sowing by going round the plot once—each side serving a range of three feet. Long, narrow plots ensure good levelling, even-sowing, good germination and an even-stand. The channel between two rows of plots is about 2½ feet wide, part of which is occupied by the thin *bunds* forming it and marking out the plots which are thus left with a clear width of three feet. This channel provided soil for the plot *bunds*, and, now that the plots are ready, serves as an irrigation channel, drainage main, and highway to the row of plots—all in one.

Labels.

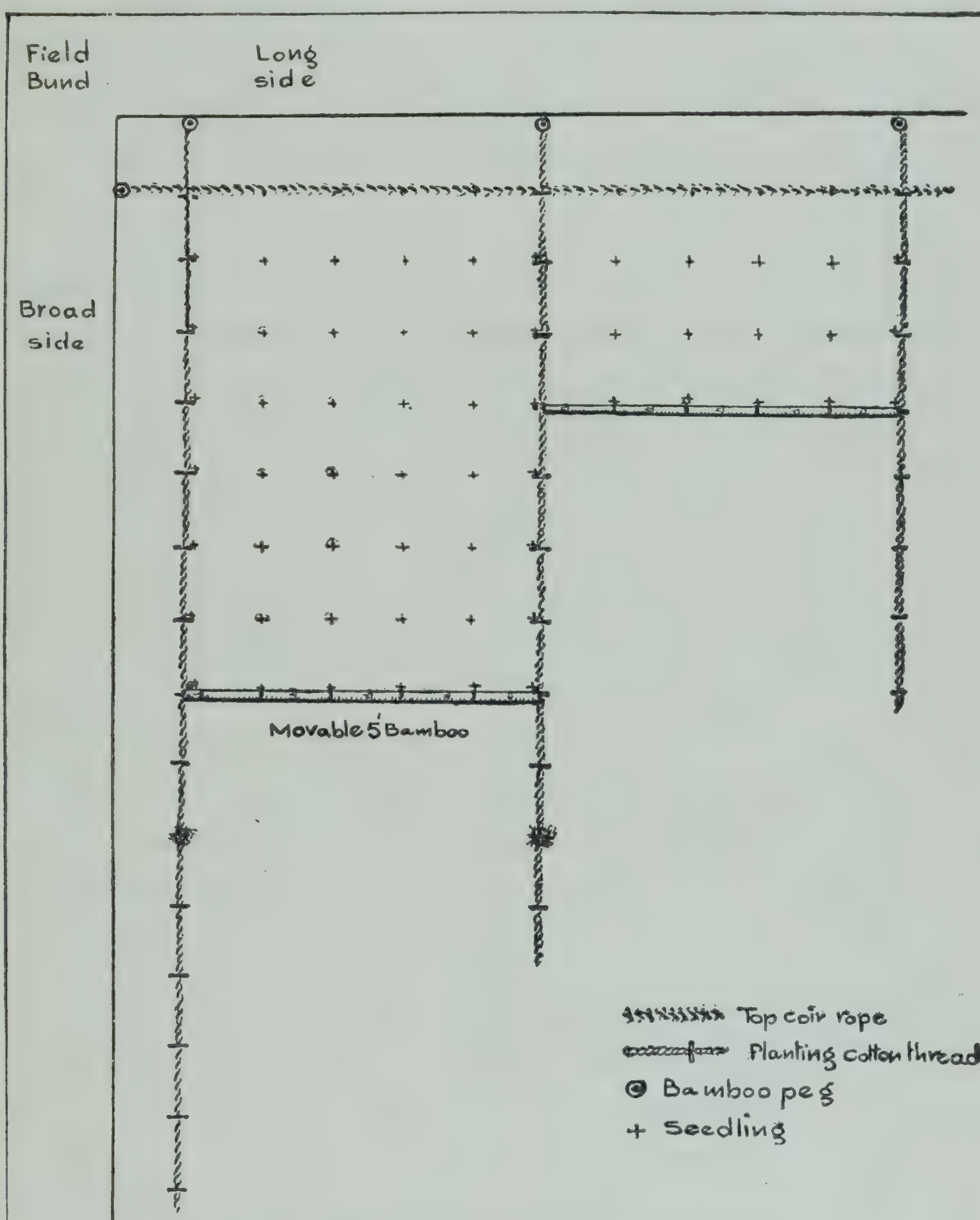
Chips of light wood about 3½ inches long and an inch wide, with a hole at the top to take in a thin iron or copper wire which fastens them on to a bamboo stake 3½ feet long—this is the commonest field label. The numbers are written with black japan. At the end of the season the numbers are shaved out and a fresh surface exposed. The labels are made of sufficient thickness to stand the shaving a number of years. Stakes should be of mature solid bamboo sides, and are kept serviceable fairly long if heavily tarred at the end of every alternate season. Eyeletted card labels with hempen twine to serve for fastening are most commonly used. A thin herbarium millboard is easily cut into any number and kind of

labels, and with a pair of punch pliers and a good stock of hempen twine the label problem is easily solved. All card labels should be paraffined after being written on. I have found that holding the ends of the hempen twine and dropping in the written label into paraffin very near boiling, and letting it simmer along for a few seconds, works the paraffin thoroughly through and leaves it with a decent glaze and no daub.

Transplanting.

Transplanting in bulk is done ordinarily about 9 inches apart. Blocks intended for *seed* multiplication are preferably planted in rows a foot apart, and the plants about six inches in the row. In every case it is best to leave a foot all round the field unplanted. This is easily done by putting a coir rope tight between two pegs planted a foot away from the *bund*. This rope line is planted out first and the centre filled up as the rope planting party is going ahead. There is often a tendency to plant these rope lines a bit too close, and this should be avoided. The advantages of leaving a foot all round are: (1) the *bunds* are easily kept clean with considerable diminution in chances of disease, (2) the general field sanitation is better attended to, (3) there is enough safe room to move about among the fields without brushing against crops flowering or heads mature, (4) the border plants do not get extra vigorous and extra tall and mar the evenness of the block, and (5) the planted blocks get to be at least about $3\frac{1}{2}$ feet from each other (allowing for the eighteen-inch *bund*)—a condition which considerably diminishes the chances of natural crossing. Character lots and lots intended for intensive economic study are planted one foot apart either way. For this purpose two coir ropes are put in position one foot away from the top and bottom *bund*, respectively (*see* Figure). These two *bund* ropes, being parallel, serve as it were as rails along which to move the actual planting ropes. These ropes are of strong twisted cotton thread, about the thickness of a diary pencil, soaked well in water and stretched out tight to ensure against any undue lengthening out during the continual soaking they are soon to experience. These ropes are secured to pegs at each end. Starting

from the top peg at intervals of every foot is inserted a bamboo slip about an inch and a half long, grooved breadthwise about the



Transplanting a foot apart

middle to take in the thread and get securely sewed on to it. Two ropes are laid across the width of the field, the first one a foot away from the *bund* on the breadthwise side of the field. The other rope is laid parallel five feet away from the first one. There is thus marked out an oblong five feet wide with foot-marks on either side

of the ladder as it were. The many bamboo bits along this rope serve to keep the rope line clear and prevent an easy imbedding into the soft puddle on to which it is laid. This five-foot width represents the convenient planting range of one woman. More ropes could employ more women. For rapid planting two trained planters could be put into one gap. In actual practice the breeding station uses in each of its two or three planting parties six ropes in the five gaps of which work ten women. At this rate a decent area is covered per day. Each woman has a bundle of seedlings in her left hand and a five-foot bamboo with bold foot-marks in the other. This bamboo is laid across the planting gap between the ropes from bamboo bit to bit and a seedling planted at each mark of the bamboo. One line over, the bamboo is removed to the next foot-mark moving backwards and on and on till the gap is finished out. One of the planting ropes is then moved down to bring about the next five-foot oblong, and when this too is planted up the operation is repeated till the whole field is covered. For the sake of convenience, every tenth bamboo slip has a bit of coir rope prominently knotted round it so that at the bottom row the correctness of the counts is easily checked from the nearest knotted tenth. There is a reserve of marked rope twisted round the bottom peg, to admit of usefulness in fields of varying width. Care should be taken that as the women walk back no seedling is planted into the hollows of their footmarks ; but the women easily learn to level out the bamboo zone prior to planting the seedlings. This system of space-planting has, with all the little modifications and accessary aids acquired in the practical working of any system, been so perfected that the whole operation works very easily and quickly. All that is required is two men, one on each side of the *bund*, to move the ropes along, plenty of five-foot bamboo sticks and a few 4, 3, 2 and 1 foot sticks for interim and final adjustments, which the length of the field and the quantity of the available seedlings might necessitate. A casualty in a foot spacing means a gap two feet square, and this will, when any economic problem is involved, eliminate the usefulness of the eight adjacent plants. It is hence desirable that as far as possible there should be no gaps. To ensure this, only good and healthy seedlings

are planted. A system of filling in gaps, a few days after transplanting is over, has been practised, and for this it is advisable to maintain a reserve of spare seedlings by planting an extra middle row six inches apart in the end two or three rows of each block. These might later be moved into the gaps if any, or pulled out. The fields have to be absolutely level and there should only be just enough water to let the bamboo lie slightly imbedded in the soft mud and prevent it floating. For safety against wind the planting is begun from that side onto which the wind blows, and to guard against bending and breakage of the seedlings planted their tops are nipped off. If two blocks are planted side by side a two-foot interval separates them. Crabs have occasionally given trouble by nibbling the seedling at the base and have proved, especially at Tanjore, a nuisance to the sprouting seedlings, and the only curative measure against them was to put a few women to be continually catching and destroying them. The tiny little ones slip through this campaign and a cheap and effective method of getting rid of these is yet to be suggested.

FLOWERING.

Even heading being an important economic factor, a system of noting the degree of such evenness has been devised. Progeny from a single plant are all planted one foot apart either way, so as to form a block. Bamboos are stuck in at every tenth plant both lengthwise and breadthwise. This marks the block out into regular sub-blocks ten square—so much so that from any place in the block the location of a particular plant is easily made, *e.g.*, 27th row 16th plant, reading down with the help of the bamboos. Having fixed the latitudes and longitudes, a chart is made out, in which each square represents a single plant and the date on which that plant flowers is entered. A cooly trained in this work walks up and down the line and shouts out the particular plant in flower and a literate subordinate sitting on the *bund* opposite follows him in the chart and notes the date. For purposes of flowering it has been found convenient to note the date on which the first main head emerges out of the sheath and shows out the white downy ring at the bottom of the panicle. Casualties in the

block are marked zero. If the flowering runs through parts of two months, beginning late in one and running long through another, an additional letter is added to the fewer group of dates, *e.g.*, 29th December to 10th January: the squares entered up in December will have 29 D, 30 D, 31 D, and the other entries will be simply 1, 2, 3, etc. The entries being over, the results are tabulated and put on to a graph. It has been found in practical experience that marking flowering is better done on alternate days, as this means less trampling about, more lots to handle and a larger evenness in the distribution of the numbers obtained on tabulation. This method of marking flowering has been of very great help in estimating the range of flowering in a pure family as also in very many families splitting for this factor. Various interesting correlations with other morphological factors have thus been enabled to be worked out.

Selfing.

Selfing is a necessity and as it does to a small extent interfere with the very free setting of the seed, it is desirable to confine this to absolutely necessary cases. There have been stray instances in which the colour of the paddy was interfered with on bagging, and it is therefore desirable that one or two plants in a selfed group should be grown naturally to serve as a check. The bagging is done as follows:—A bamboo is planted close to the plant to be bagged, it being at least nine inches taller than the probable height of the plant when heading is over, and three more bamboos take their place on three corners of the plant just as wide away from it as to allow of enough spread inside. Care should be taken that one of the bamboos takes its place on the side from which the prevailing winds blow. This ensures a wedge-shaped frontage to the bagged area and leaves the bag secure even in heavy winds. A triangular bag about a foot each side is then slipped over this frame work, down to well within about a foot of the highest water level and secured to the bamboo at the corner of its bottom edge on the windward side by means of a tape sewed on to the bag. The plant is labelled both to the central bamboo and to one of the outside ones. The central bamboo being taller prevents a cup-shaped

depression and secures a pyramidal top. The cloth used is the muslin commonly known as 1702 mull—manufactured by J. & A. Leigh, Preston. With proper care a bag easily lasts for three years. Two precautions have to be taken. The bamboo must be smoothened at the nodes and the top of it is to be a nodal septum, smooth and rounded out, so as not to take in and retain any rain water. These precautions prevent the bag from rapid depreciation and tearing, and make it last long. The bagged plant has its old lower leaves scissored off, and a string is *loosely* passed round the plant to keep the outer row of tillers from rubbing against the bag during growth. The string when put round too tight has interfered with the free ventilation of the tiller mass and has resulted in damage to a few central tillers. The bag may be removed when all the main heads have finished flowering, and what few heads may come out later can be cut away, leaving the initial bunch of prime heads free to be gathered when ripe, without having to wait for the weakling stragglers.

Rogues and roguing.

I consider roguing the most fascinating of all experiences. The amount of natural crossing in rice has been variously estimated up to about 3 per cent., and this offers one of the natural sources of the presence of rogues in a pure crop. Added to this are the immense chances of an odd grain or two getting mixed with a pure lot in a hundred little ways which will be within the experience of anyone handling lots running often over a thousand. These unwelcome plants are of two kinds: (1) mixtures and (2) natural crosses—the mechanical mixtures and chemical compounds of genetics. Both are undesirable and should be watched and promptly pulled out to maintain the purity of the family. A stranger plant is easily detected, in that it flowers either very early or peeps out green when all the neighbours are ripe. Its colour and habit often mark it out. Anyway it is easily detected and dealt with. In the case of contemporaries they cease to be strictly such, and are often ahead of the family. Extra vigour, a marked prominence right from the start, often a difference in habit, mark these out easily. It is a common experience that after a little time one gets easily to develop

an eye for a rogue. In the seedling stage itself, a keen eye easily detects what is sure to prove to be an intruder, and often the suspicion turns out at flowering time to be well founded. In a non-purple-pigmented variety, pigmented strangers are easily spotted. But colourless rogues are a hard lot and give more trouble. Habit, height, duration, and above all the general droop of the panicle provide guides to them. In an even-flowering variety with a continuity of stretch in the heads, a stranger strikes a discordant note and arrests the attention of the passer-by. It is highly desirable that anything suspicious, well or ill founded, is pulled out straight away before its dubious pollen begins to taint the neighbours. This may mean innocent victims, but it is better to err this way. I have come across instances of a few early heading plants true to type, and a fair number of these isolated and grown proved to be slightly pigmented rices. This apart, it is desirable to eliminate the stragglers, both early and late, as by so doing we eliminate the chances of accentuation of uneven heading in the next season's crop. A most efficient method of trying to locate a rogue is to sit on the *bund* and look low and level with the height of the plants, and any plant sticking up easily betrays itself. This means a margin to the plant block, not extra high and giving the block the look of a very shallow dish, but the securing of a normal margin. The leaving of a foot all round the plot is useful in this as in other ways. Roguing involves continual movement among the plants, and as it is not desirable to disturb plants in shot-blade by indiscriminate treading, the desirability of definite spacing, with consequent interspaces, becomes patent. They ensure safe movement and have the additional advantage in that the regularity of planting serves to tune up an orderliness and uniformity, in which anything out of the way is spotted out easier. Roguing has to be done at three different periods : firstly, before the variety is in general flower, secondly, during full flower, and, thirdly, when flowering is finished and late plants linger on. The most desirable thing to do is to move about the plots continually and pull out plants any the least suspicious, immediately they are detected. It is not desirable to postpone doing this, as once lost sight of they are not

very readily spotted out again. Light has an important influence on the ease with which a rogue is spotted, and it will fall within the easy experience of one in the work to be surprised to find that a rogue quite near one *bund* was missed till its presence was revealed from the distant *bund* opposite. In my opinion it pays richly to examine a crop from all positions and at varying times.

All this refers only to pure families and bulks, and I would here give a warning against any interference with definite splitting families, as what a beginner would lightly take for a " rogue " often proves the very plant with that rare chance combination of characters we are all delightedly familiar with in the course of Mendelian experiences.

Storing.

In breeding work we deal with large numbers of *single plants* and when any of these get multiplied we get what is a *pure bulk.* It is the handling and safe storing of these that will now be considered. The single plant is best harvested close below the panicles, and the whole lot of heads is then put into a long muslin bag. A label is put in and a knot secures the mouth of the bag. Another label is tied round the neck below the knot. This guards against mixture and impurity. The only chances of any stray seed coming in will be through sheer neglect, and to guard against this the mouth of the bag is examined before unknotting it, and later when the heads are removed for stripping the seed off the panicles, the bag is turned inside out and all stray grains carefully removed prior to storing away the bags. These single plants in muslin bags are safely and easily put out to dry and are then stored packed in bins, till the stress of the harvest is over and time is found for stripping and bottling them. The stripping is easily done, a cardboard winnow proving quite efficient and not harbouring stray grains. This over, the seeds are put into wide-mouthed, tin-screw top bottles. These bottles are of varying sizes, *viz.*, 4, 8, 12, 16 and 20 oz. capacity. For ordinary purposes, 4 and 8 oz. are the sizes for single plants, and very occasionally a 12 oz. bottle may be needed to take the seed of an extra vigorous individual. These bottles are very convenient and highly commended for general use in all paddy work. A numbered card label dipped in liquid paraffin is put into

the bottle, as also a *ball* of naphthalene which ensures absence of moths without in any way seriously impairing the germination capacity at least for a couple of seasons. The naphthalene ball is of course removed prior to the soaking of the grain for sowing. Larger quantities of paddy up to about 10 lb. are easily stored in drill bags about a foot square. These have to be carefully stitched so as to allow of easy examination of chance seeds in their stitch folds, and to have a tape loop sewed on to one end of the mouth for convenient labelling. The neck is secured with a tape, and inside the bag is put in the wooden labelled chip marking the plot in the field. Still larger quantities, up to about 25 lb., can be stored conveniently in kerosene tins with well-made lids fitting on to the top cut entirely out. A little tin loop soldered on to the *body* of the tin (not the lid) is the provision for tying the label. The soldering of the bottoms of the tins as purchased is often imperfect, allowing of chinks harbouring stray seed, and these have to be beaten close and if need be resoldered and filled up. For very large quantity of seeds bins somewhat similar to those described by the Howards[1] are used. The last thing to use in a paddy-breeding station—though without it, it is well nigh impossible to get on—is a gunny bag. It is a treacherous receptacle, bristling with possibilities for acute trouble regarding the purity of the seed handled and stored. The best way of minimizing this necessary evil is to purchase *new* gunny bags and keep up a steady inflow of this, as seeds go out of the station in the previous year's bags. The fresh ones should be used for the new year's *seed* and the old ones for other less important storing. It pays well to keep a man going over emptied bags, bins, tins and bottles, and make sure that no odd grains lurk inside them. It would fall to the easy lot of all breeders to come across servants possessed of great care and absolute veracity, to whom this work is very safely entrusted.

Before concluding, I wish to express my grateful thanks to Mr. F. R. Parnell, Government Economic Botanist, whose genial encouragement gave me ample opportunities for the gathering of these experiences.

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[1] *The Agri. Journ. of India*, XV, Pt. 1, p. 9.

Selected Articles

THE GROWTH OF THE SUGARCANE.*

BY

C. A. BARBER, C.I.E., Sc.D., F.L.S.

VII.

THE length of the cane depends on two different factors, the length of the individual joints and their number. Taking the cultivated cane plant in general, there would not appear to be much difference among the varieties in these respects. In every case the number of joints is considerable, for as each joint bears only one leaf and these are constantly growing old and being discarded while new ones are appearing at the top, the continued formation of fresh joints is a necessity in a growing plant. Given the conditions necessary for continued healthy growth, the plant will thus go on forming joints until it dies or, as is so often the case, arrows: then all growth in length ceases. Joints once formed and meeting the eye of the observer do not increase in length, for, as we saw in the last article,[1] the increase in length of the individual joint takes place while it is still hidden in the mass of young leaves and, indeed, completes itself in a very short time. After that, the joint never alters in size, and the increase in length of the cane is entirely due to fresh joints being added above those already formed. By counting the joints at harvest time, we can at once tell how many leaves the plant has produced above ground, those in the terminal tuft being of course added.

* Reprinted from *The International Sugar Journal*, July 1920.

[1] *The Agri. Journ. of India*, Vol. XVI, Pt. 1.

In spite of this general uniformity, we have short and tall canes, long and short-jointed forms, canes with comparatively many or few joints. And these are, all of them, matters of importance in regard to the amount of crop yielded. The height of a field of cane will, as everyone knows, vary a good deal according to the weather, the soil, and the care in cultivation and amount of manure applied. And the effect of these external variations is perhaps more to be seen in the length of the individual joints than in the number produced. The length of the joints is immediately affected by any local injury, the plant reacting against such injury by producing for a time, or permanently, shorter joints: and any cane not growing well will show its condition in the joints as well as in the leaves, by producing shorter ones. Thus B.208, which has been most extensively tried in all parts of India because of the richness and purity of its juice, has on the whole been disappointing, being usually characterized by thick short joints with a strong tendency to shooting at the nodes. The climate appears to be generally too dry and perhaps the heat is too great for this cane to do well; but the writer has met with it in two widely separated districts where good, long joints are formed without much shooting, and the canes here were of so different a form that it was difficult to believe that it was the same kind of cane. Repeated observations have shown that in no character does the cane plant respond more rapidly to climatic conditions than in the length of the joints: and in parts of Bengal, at reaping time, the portion of the cane growing at the onset of the monsoon can be readily marked. An extreme case of this kind of periodic change in the length of the joints is shown in the reproduction of a photograph shown on Plate XIII. Beyond that these canes were grown in Central Queensland nothing is known of the details of the crop, but it would have been interesting to learn what was the cause of the change. It may be suggested that the simultaneous shortening of the joints in all the canes of the crop shown had something to do with the approaching end of the growing period: but its long continued nature might also suggest a marked period of drought succeeding good growing weather. We shall return to this aspect of the subject later on, merely

A Queensland Crop of Canes showing a sudden Change in the Length of the Joints.

noting here that sudden climatic changes have again and again been seen to produce similar changes in the length of the joints.

Another factor which has influence on the length of the cane joint in a given plant is the period at which it is formed. We have seen[1] that the early and late formed canes of a clump differ very considerably in this respect. The first formed canes are distinguished, among other things, by relatively shorter joints than those arising later in the plant's growth ; but, in spite of this, the earlier canes produce so many joints that they are usually the longer. This makes it rather difficult to determine accurately the appropriate length of joint in the different varieties. But a further difficulty is met in the fact that in each individual cane the length of joint varies a great deal with the part of the cane where it is measured. Commencing with extremely short, disc-like joints in the part usually below the ground, where the plant is engaged in attaining the thickness proper to the variety,[2] the length of the first joints above ground rapidly increases as we pass upwards. During the period of active growth a succession of good, long joints is formed and, towards the close of this period, they often become quite short before the cane is cut at harvest. When flowering occurs this normal curve of growth is interrupted at the end, in that the joints at the top become longer again, sometimes enormously so, and it is thus possible to tell, long before there is any appearance of the future inflorescence swelling within its sheath, that the cane is going to arrow : the leaf sheaths become also longer while the blades become shorter, and the joints greatly decrease in thickness and become useless for the crop.

In attempting to judge the length of joint appropriate to the variety, one would in these circumstances naturally confine one's attention to the middle of the cane, assuming that in this part the joints would remain more or less constant and indicate the normal length attained. But this is far from so simple a matter as it appears, for the joints vary a great deal even in this part, and there is some

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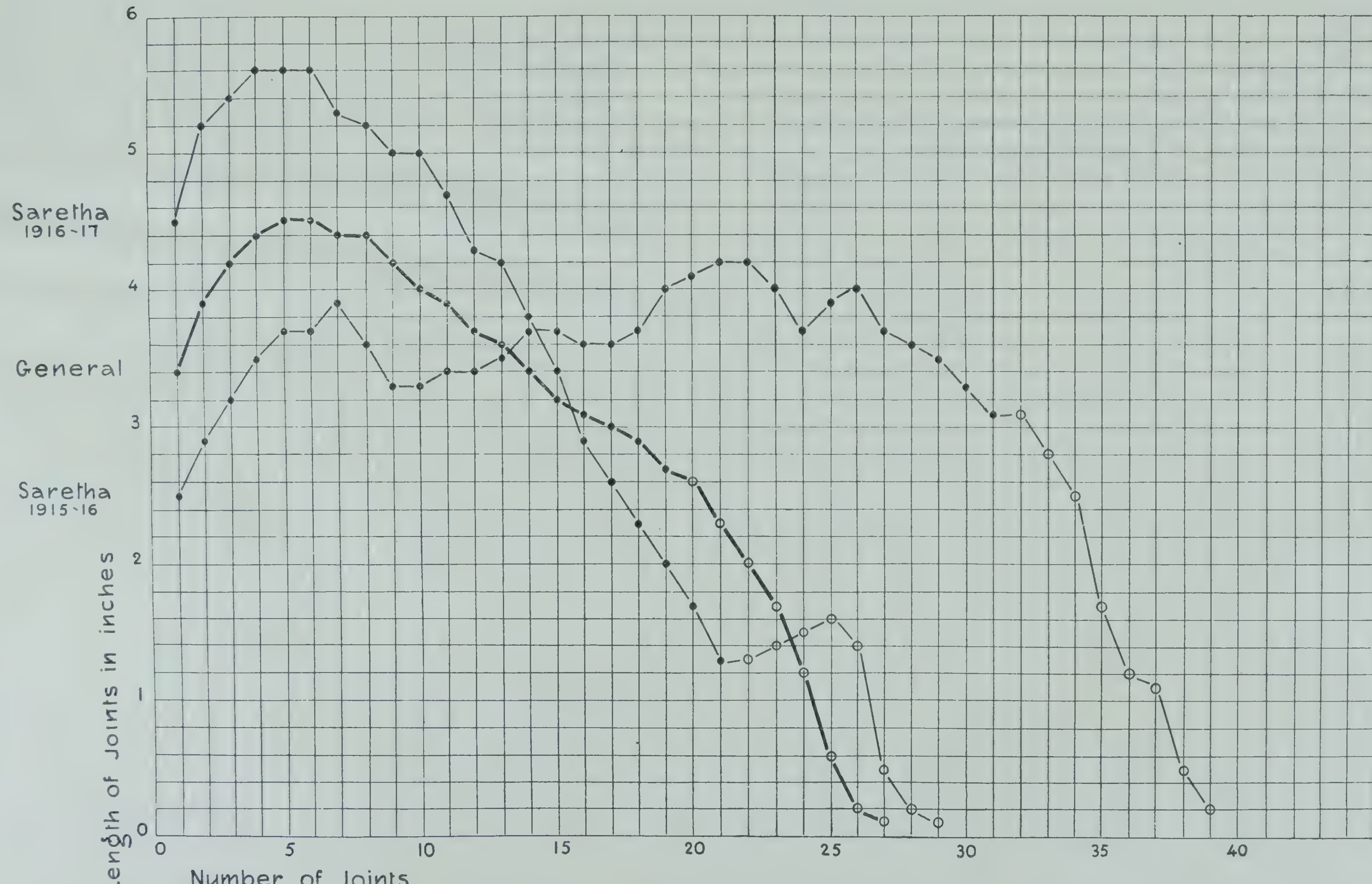
[1] *The Agri. Journ. of India,* Vol. XV, Pt. 6.

[2] *The Agri. Journ. of India,* Vol. XVI, Pt. 1.

evidence of a rhythmic change in length during active growth, waxing and waning periodically. But the most important point brought out by a careful study of a very large number of canes is that the longest joints are to be found much nearer the ground than the middle of the cane. The length of the joints from base to apex has been measured by the writer in many thousands of canes, and in a batch of 2,000 belonging to widely different varieties (entailing some 40,000 measurements) it was found that, on the average, the fifth and sixth joints above the ground were the longest. It was also noted that the very first joint above ground was comparatively long, that the increase in length was very rapid till the maximum was reached, and that, further up the stem, there was a regular fall until the short joints at the end of the growing period were reached. As there were, on an average, 20 mature joints in each cane, the point at which the longest joint was met with was thus exactly one-quarter of the way up, counting the number of the joints. The following were the averages, in inches, for this series of measurements, from the ground to the highest matured joint of the cane :—3·4, 3·9, 4·2, 4·4, 4·5, 4·5, 4·4, 4·4, 4·2, 4·0, 3·9, 3·7, 3·6, 3·4, 3·2, 3·1, 3·0, 2·9, 2·7, 2·6. These figures of the average length of joint in the 2,000 canes are graphically shown in the accompanying diagram in the curve marked 'General,' and this graph shows very clearly the typical joint curve of a sugarcane (Plate XIV).

At the same time that the joints were measured in all these canes, various other measurements were made, including the lengths of the leaf blade and leaf sheath, and typical curves were obtained which differed very widely from that of the joint. We can here only very briefly refer to that of the leaf blade. The lamina borne by the first joint above ground is usually about a yard long, and succeeding leaves are longer and longer until a maximum is reached, as in the joint. But this maximum, which is usually from 5 to 6 ft., is reached much later than in the joint. When it is attained the succeeding leaves remain very uniform in length during the period of active growth, while towards the end of the growing season the length rapidly decreases. The general curve is, therefore, a flat one as compared with the sharp-pointed one of the joint, and it is

Joint Length Curves, Saretha, Samalkota, in 1915-16 & 1916-17, & General Curve, of the Whole 89 Observation Units



The dots represent successive joints from left to right, commencing with the joint at ground level. The circles

probable that, as long as the cane plant is growing normally, the length of leaf blade remains fairly constant. As an example, we will take the measurements of the leaf blades in the Saretha group of Indian canes, and the averages given below are those of a very large number of canes in different numbers of this long-leafed group of canes. The following are the figures, in inches :—37, 38, 42, 45, 48, 51, 52, 53, 54, 55, 56, 56, 57, 57, 57, 57, 56, 57, 57, 57, 57, 56, 55, 55, 54, 54, 53, 51, 48, 37, 26, 17, 8. In this series it is seen that the actual maximum was not reached until the sixteenth joint, and that for 28 successive joints the differences in length were less than 10 per cent. All the leaves of the plants were measured from the first joint above ground upwards until a lamina was reached at the top of the plant less than 1 ft. long.

Let us now return to the curve of joint length, which concerns us more especially. From the mass of material recorded I propose to describe a case which shows that, with a little study, the length curve of the joints taken at harvest bears, indelibly stamped upon it, the nature of the past growing season, and that any abnormality will make itself clearly noticeable. This method has been extensively used in a paper by the author[1] dealing with the suitability of any cane for the locality in which it is growing, the observations being made once for all at crop time, instead of in a continuous series throughout the season. The work can thus be extended to a large number of districts by simply deputing a careful subordinate to make measurements according to a given schedule.

In a series of measurements thus obtained at Samalkota, in 1915-16, the curves showed certain peculiarities which tended to discredit the reliability of the method ; those of the joint length in four kinds of cane, although agreeing remarkably among themselves, were quite abnormal ; they even resembled the flat leaf curves rather than the typical sharp joint curves which had been

[1] C. A. Barber. "Studies in Indian Sugarcanes, No. 5. On testing the suitability of sugarcane varieties for different localities, by a system of measurements. Periodicity in the growth of the sugarcane." *Mem. Dep. Agri. India, Bot. Ser.*, X, 3, 1919.

obtained in hundreds of cases all over India. The curve obtained for Saretha in that year is shown in Plate XIV. It is seen that the maximum joint length, although approached in the seventh joint, was not actually reached until the twenty-first; that between the seventh and twenty-sixth joints only minor differences in length occurred; and that the curve was very long, no less than 33 joints being formed and matured before the rapid diminution of length at the top of the cane. In 1916-17 the observations were repeated at the same place with the same set of varieties which had been growing for the same number of months. In every case a typical joint curve was obtained, and that of Saretha is again reproduced on the plate. Saretha is a cane that has a rather greater number of joints than most others and, in the second year, it is seen that they were not appreciably more than the average for the whole series of canes of this and other varieties dealt with in the 'general' curve. The canes in this year were, therefore, just as few-jointed as those in the previous year had been many. The maximum is high, as is usual with Saretha, was reached very quickly, namely, in the 4th joint, but the descent was more rapid than usual to the 21st, when the immature part of the cane was reached.

As this divergence of the joint curves (shared in by those of the leaf, lamina and sheath) was so unusual, a careful study was made of the weather records published every year by the Station. The explanation was at once found there. To summarize, the monsoon was delayed in 1915-16 and the canes had a difficult time at the beginning of the season: later on things improved and the latter half was peculiarly favourable to rapid cane growth. In 1916-17, on the other hand, the monsoon broke very early and the rain was satisfactory right up till October, when canes were commencing to be formed rapidly: then the difficulty, often experienced in the delta, was to get the land drained, and even paddy suffered considerably from the excess of water on the land. In both seasons the amount of rain that fell was reported to be 'well above the average': in 1915-16 the first half of the season was unusually bad and the second unusually good: in 1916-17 the reverse was the case.

This clearing-up of the difficulty was opportune, and added strength to the conviction which was forming in my mind that a series of careful measurements made at crop time may be relied on to reproduce the character of the cane growth throughout the season that has passed. Further, that from a study of the joint and other curves of growth, obtained by local officers, the suitability of a tract for cane growing in general may be judged, and reliable data may be obtained as to the relative suitability of a number of different varieties being tested.[1]

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[1] C. A. Barber. *Ibid.*

PROSPERITY AND DEBT IN THE PUNJAB.*

BY

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It has been said that nowhere in the world will you find a prosperous and contented peasantry. A perusal of the Land Revenue reports of the last 15 years suggests that the Punjab is perhaps the exception that proves the rule. But this was not always so. Twenty years ago things agrarian provoked deep anxiety and clashing views. The agriculturist was losing his hold upon the land. Indebtedness was increasing. The area redeemed was always less than the area mortgaged; and the money-lender was master of the situation. At last, in 1901 †, after much enquiry and searching of heart, when even the Revenue pundits had nothing more to say, the bull was taken by the horns and the Land Alienation Act was passed. This Act has rightly been termed the Magna Charta of the cultivator. To him it is the only Act that matters. He can no longer be ousted from his land, and he is no longer as wax in the hands of the usurer. With it too has come a new era of prosperity. The price of land, in spite of the Act's restrictions, has doubled. In some areas it has increased fourfold. Credit has expanded, prices have risen, and a widely extended system of irrigation has made famine well nigh impossible. Finally, this is a point that all official reports stress, since the Act came into force the area redeemed has almost invariably exceeded the area mortgaged. Prosperity, therefore, reigns, and the Revenue expert, no longer anxious, sees his work that it is good. Such is the impression

* Reprinted from *The Ind. Journ. Eco.*, III, 2.

† The Act came into force in 1902.

made by the official reports and reviews of the last 15 years. It is a picture almost without shadow, and it must be admitted that such pictures are apt to be unreal; but then it is a picture of prosperity, and in the imagination at least prosperity has no serious shadows.

Turning now to the statistical statements that accompany the official reports, we are suddenly confronted by the unexpected fact that throughout this period indebtedness has steadily increased.* In 15 years (1903 to 1917) the net increase in the mortgage debt of the province exceeds 10 crores of rupees. Of this nearly $9\frac{1}{2}$ crores falls upon owners and share-holders. Dividing the 15 years into periods of five years each, the figures in lakhs are as follows :—

	Rs. lakhs
1903–07 ..	161
1908–12 ..	231
1913–17 †	541

I have excluded the amounts for which tenants are responsible, as this article will deal exclusively with owners and share-holders. It will be seen that there is a rapid rise in the figures of the last five years. If indeed only the last three years are taken, the increase is startling, being nearly four crores of rupees. This is actually more than the amount for three years immediately preceding the introduction of the Land Alienation Act when the increase was only 3·11 crores.‡ This is the more striking as two years of the earlier period were years of famine and only one was a good year, whereas of the last three years the worst (1916) is officially described as "unfavourable" while the last (1915) is called "a record year."

It is curious that so remarkable an economic phenomenon as this steadily increasing indebtedness§, vitally affecting the condition

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* Some deduction must be made on account of mortgages which at the end of a fixed period are automatically extinguished, but informal enquiry suggests that in most districts this form of mortgage is uncommon.

† Figures for the year 1917-18 were not available when this article was written.

‡ North-West Frontier Province excluded.

§ Some deduction must be made from the figures given above on account of mortgages to non-agriculturists, which under the Land Alienation Act are automatically extinguished after 20 years without payment. Informal inquiry, however, suggests that the deduction to be made on this account is small.

of over $3\frac{1}{2}$ million proprietors, should have passed almost unnoticed. Indeed diligent search through the official reports of 20 years has discovered only one or two allusions to the fact that the money borrowed by mortgage exceeds the amount discharged by redemption. Yet for over 20 years this has invariably happened. In 1896 it was admitted that indebtedness was rapidly increasing, but after that there is no further reference till 1910. In that year the redemption of 415,000 acres for two crores and the mortgage of a much smaller area for $2\frac{1}{2}$ crores is cited as evidence of the increased value of land. The more important point that it is also evidence of increased indebtedness is ignored. In 1913 there is a final allusion. In that year net mortgage debt rose by over 72 lakhs. The fact is recorded, but without comment. On the other hand throughout this period there are innumerable references to the fact that the area redeemed exceeds the area mortgaged, and again and again, with almost ritualistic repetition, the subject is made matter for congratulation. Doubtless acreage is an important consideration, but after all the prime object of a mortgage is money. If more and more money is raised by mortgage, the fact that at the same time the area under mortgage is decreasing does not justify unmixed congratulation. The official review of 1915 remarks that "it is very satisfactory to find that not only the proportion, but the actual area of land under mortgage is now less than in any year of which we have a record." Yet in this year net mortgage indebtedness increased by well over a crore of rupees. In the following year the increase is 140 lakhs, the highest figure ever recorded for the province. Turning to the year's report for some explanation of this we find the bare statement that "it is the first time in the last five years that the area mortgaged has exceeded the area redeemed." In 1917 *, the last year under report, the increase is only two lakhs less. This time we are promised an investigation, not however because for 20 years debt has steadily increased, but because for the second year running the area mortgaged exceeds the area redeemed.

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* This article was written in November 1918. The report for the year 1918 is, however, no exception to what has been said above. Net mortgage debt in 1918 appears to have increased by over 150 lakhs, making a total increase of 430 lakhs for the last three years (1916—18).

In this connection there is a further point to note. Recent enquiries into the indebtedness of members of co-operative societies in the Punjab, who may be regarded as typical of the proprietors of the province, suggest that one rupee of mortgage debt means at least another rupee of unsecured debt as well: that is to say, that to estimate total indebtedness the mortgage debt should be doubled. This would mean that during the last five years the total indebtedness of owners and share-holders has increased by eleven crores, or over £7,000,000. For ten years, the figures would be well over £10,000,000. * In 1896, Sir Frederick Nicholson estimated the total debt of the Madras Presidency, which in population is now twice as big as the Punjab, at £20,000,000. An increase of £10,000,000 in ten years is, therefore, considerable, and the more surprising that the period is one of undoubted prosperity. It would seem that after all prosperity had its shadow, and that perhaps in India prosperity and debt go hand in hand. Before we come to any conclusion upon the subject, however, we must try and ascertain why indebtedness has increased.

In the face of the almost total silence of the official reports, this must naturally be a matter of considerable difficulty. Statistical statements are indeed the only guide. There are plenty of these. Their name in fact is legion; but as a guide they have something of the erratic nature of the first possessor of that name. It is not only that all statistics may easily mislead; but these in particular have been collected for a purpose which is quite different from ours and under conditions which are constantly changing. Thus in the last twenty years, two new provinces have been carved out of the Punjab, the North-West Frontier in 1900, and Delhi in 1912. Allowances too have to be made for changes in district boundaries, and a final difficulty is the elusiveness of certain statements which occasionally disappear from one report to reappear in another. The field of Indian economics resembles a vast jungle through which as yet there is no pukka road, but only tortuous and not very obvious

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* The exchange is taken at 1*s.* 4*d.* At 2*s.* the amounts would be £11,000,000 and £15,000,000, respectively.

paths. It was, therefore, a temptation at this point to draw back and leave it to those more expert in statistics and economics to align the road. This attitude, however, never led to either adventure or discovery. I have, therefore, adventured, hoping that others may be tempted to follow in my track, and that so doing they may find the path less tortuous or at least more obvious than before.

The first point to note is that in the last five years, with the unimportant exception of Simla, every district in the province shows an increase in net mortgage debt, and even in the preceding five years, when the increase was much less, only four * districts show a decrease, which too is no more than a total of 6½ lakhs. It is clear, therefore, that the increase in debt is widespread, though in the north-western districts it is less marked than elsewhere.

There are 28 districts in the province, and as it is impossible within the narrow compass of an article to examine the conditions prevailing in each, I propose to take the worst cases, in the hope that where the malady is most pronounced the symptoms may be most evident. There are no fewer than nine districts, representing about one-third of the Punjab, in which during the last five years the increase in mortgage debt exceeds 20 lakhs. The figures, which are in lakhs of rupees, are as follows ; and to show the rate of increase, figures for the preceding five years are given as well : —

	1908–12 Rs.	1913–17 Rs.	Total Rs.
Ferozepore	34,75	76,34	111,09
Amritsar	29,08	49,22	78,30
Sialkot	16,56	37,65	54,21
Lahore	21,43	28,29	49,72
Gurdaspur	14,05	31,68	45,73
Lyallpur	1,13	43,38	44,51
Hoshiarpur	12,00	29,13	41,13
Ludhiana	17,09	22,87	39,96
Jullundur	1,87	26,06	27,93

As there will be frequent references to these districts, a word may be said about each. Three of them, Sialkot, Gurdaspur and Hoshiarpur, are submontane districts highly cultivated, thickly

* Gujranwala, Montgomery, Multan and Dera Ghazi Khan.

populated and blessed with a good rainfall. Jullundur, Amritsar and Lahore belong to the Central Punjab, and are the home of the Sikh Jat, an excellent cultivator if somewhat extravagant in habit. Like the submontane districts they are highly cultivated, but being more irrigated are even more densely populated. The connection between irrigation and population is worth noting. Ludhiana is south of the Sutlej, and broadly speaking resembles the central districts, enjoying, however, less irrigation but more rain. These districts are the home of the small proprietor, whose average cultivated holding varies from ten acres in Lahore to three and three-quarter acres in Jullundur. Excluding Lahore, the maximum average is only six acres. There remain the two districts of Ferozepore and Lyallpur. In these areas cultivated holdings are for the most part larger, the average being 15 acres in Ferozepore and nearly 20 in Lyallpur. In Ferozepore large holdings prevail because the rainfall is too scanty to permit of a large population. Lyallpur is too well known to need description. It is, of course, the most famous of the Punjab canal colonies. On the whole these nine districts are typical of economic conditions in the Punjab, which is a province of small proprietors, with here and there a district of larger holdings. In only one district out of the 28 (namely, Hissar) does the average cultivated holding exceed 20 acres, and in 19 it is less than 8 acres. For the whole province the average is seven and a half acres.

The district that shows the greatest increase in mortgage debt is Ferozepore. In ten years, it has risen by over a crore of rupees. In two other districts, Amritsar and Sialkot, the increase exceeds 50 lakhs. Assuming, as before, that total indebtedness is not less than double the mortgage debt, we find that as many as eight districts each show an increase of over £500,000. * In Ferozepore, the amount is nearly £1,500,000. † As there are in the district about

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* 75 p.c. must be added at present exchange (2*s.* 4*d.*)

† Further enquiry suggests that Ferozepore is an exception to the general rule, that total debt is not less than double the mortgage debt. The latter appears in this district to be much heavier than unsecured debt. Even so the increase can hardly be less than 1½ crores, which at present exchange is equal to £1,500,000 (September 1919).

150,000 owners and share-holders, this means an average increase of £10, or Rs. 150 per head, which, as money counts in India, is considerable. A report * of 1908 touches upon the subject, and though it is not very recent it is worth quoting as, so far as can be discovered, it is the only explanation of the increase in debt that the reports for the last 20 years offer for any part of the Punjab. "Owing," says the Deputy Commissioner of Ferozepore, "to the habit of excessive drinking in some cases and to gambling in others, the people mortgage their lands first to one, then to another for increased consideration, and again to a third person for a further increase during the course of the same year; and this fact alone accounts for the high figures under the head mortgage and redemption of mortgage." And he goes on to point out that at the same time a combination of good harvests and high prices for grain had led to an abnormal rise in the value of land, the implication being that this sudden access of prosperity in facilitating mortgage had led to an increase in debt. Here then prosperity and debt would appear to be intimately connected, and what is more serious, to have led to demoralizing † habits. As such the case is a warning to those superficial economists who regard material prosperity as the remedy of all evil. It would be unwise, of course, to apply this instance from a single district to the whole province. At the same time the fact that in the district which shows the most abnormal increase of debt, the phenomenon has been connected with demoralizing habits, shows the importance of the subject and the need of enquiring into the phenomenon as a whole.

Ordinarily, where small proprietors are concerned, the main causes of indebtedness are: (1) bad seasons, (2) increase of population without a corresponding increase in production, (3) expansion of cultivation, (4) splitting up of holdings, (5) purchase of land on credit, (6) high prices, and (7) facile credit. There are other causes such as intensive agriculture, which demands more capital, and

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* Land Alienation Act Report.

† The assessment reports of the district (1912—14) also speak of "extravagance and dissipation" as prominent causes of debt.

the power of the usurer ; but for our present purpose these can be ignored, as intensive agriculture in the modern sense hardly yet exists, while the usurer is hardly ever absent. Thanks to the establishment of nearly 6,000 co-operative credit societies, his power in the Punjab is decidedly less than it was ten years ago, so that we can hardly look to him for an explanation of the rise in debt. To ascertain this we must now examine each of the causes given above as briefly as such complicated questions allow.

Bad seasons.

The first cause is bad seasons, or to speak more accurately, though less simply, seasonal vicissitudes, as it is not only the bad seasons that run the cultivator into debt, but also their great fluctuations. In India, outside the great irrigated areas, the harvest is a gamble in rain, and this produces the gambler's habits. The Indian cultivator, therefore, is not noted for thrift. Moreover, when holdings are small, even a moderate harvest may compel a man to borrow, and if interest is high it may be difficult to pay off the debt in a good harvest. The moderate harvest occurs more frequently than is supposed. Even in districts with a good rainfall, like Gurdaspur and Sialkot, the rain is apt to come at the wrong time or in too great abundance, with the result that there may be a succession of harvests none of which will be good and none positively bad. This has certainly been the case in Gurdaspur, and has probably had much to do with the increase of 32 lakhs in the mortgage debt of the district during the last five years. The small owner there is not a man of business. In a good year he lives well. In a poor year he borrows ; and this, owing to the high value of his land, he can do with ease. Looking to the province as a whole, however, we find that the harvests of the last ten years have been above the average. There have been no years of famine as in the nineties, and only two bad years, while four were definitely good, and one, as we have seen, was a record year. The remaining three were normal or slightly below normal. Accordingly, though a few individual districts may have suffered, we can hardly attribute the increase in debt throughout the province to the seasons.

Increase of population.

Of the many causes of poverty which operate in a country like India, increase of population is the most serious, because where agriculture is stagnant mouths increase faster than food; and when agriculture is the only important industry few leave the village where they were born. The common attitude, therefore, which sees in an increase of population a sign of well-being, is fundamentally wrong. It can only be an advantage if production, agricultural or industrial, outstrips it; and even then, so far as industrial production is concerned, it is a doubtful blessing, as it leads inevitably to overcrowded towns at home and a struggle for markets abroad, and the latter as often as not ends in war. It was not, therefore, necessarily matter for regret that the last census disclosed a substantial decline in the population of the Punjab. The fact was, of course, deplored. Attention was concentrated upon the ravages of malaria and plague, and the economic advantage of a smaller population for the land to sustain was not considered. In the nineties both population and indebtedness rose considerably. I have little doubt that the one affected the other; and in view of the great increase in debt during the last five years, I would hazard the guess that the population is no longer declining,* but almost certainly increasing. At the same time, the fact that throughout the period of the last census indebtedness was slowly but surely increasing, shows that there are other causes at work.

Splitting up of holdings.

In a country where the laws of inheritance prescribe equal division of property between sons, an inevitable result of an increase of population is the splitting up of holdings, and when these are small, this is likely to be a potent cause of debt. In 1896, an exhaustive enquiry into indebtedness in four different areas was undertaken by Mr. Thorburn, Commissioner of Rawalpindi. In his illuminating

* Since this was written the mortality figures of the influenza epidemic of the autumn of 1918 have been published, showing a death rate of 5 per cent. of the population. This would probably falsify the guess made above.

report, which deserves to be republished, he says that the four most prominent causes of debt are fluctuations in yields, losses in cattle, the obligation to pay land revenue whatever the harvest, and the splitting up of holdings from the growth of population. The first two causes are really aspects of seasonal vicissitudes which have already been considered ; and if one may judge by the assessment reports of the last ten years, land revenue is no longer a serious cause of debt. There remains the splitting up of holdings. Official statistics show that there are now 136,000 more owners and share-holders and 53,000 more holdings than five years ago. The increase in the case of the former is about 4 per cent. Each of the nine districts which we are specially considering shows a similar tendency ; and in five, Lahore, Gurdaspur, Hoshiarpur, Jullundur, and Lyallpur, the provincial average is exceeded. In spite of a great expansion of cultivation, the effects of which will be discussed presently, the increase in share-holders has naturally led to a reduction in holdings. This has occurred in each of the nine districts in question. In the six in which the average holding is less than seven acres, the reduction varies from half to a quarter of an acre. For the province as a whole the average has fallen from eight to seven and a half acres. In itself this is, perhaps, not a change of much importance ; but viewed as a continuing process it is one that may deeply affect the future welfare of the Punjab. Meanwhile there can be little doubt that, in at least seven out of the nine districts (in Lyallpur and in part of Ferozepore, the average holding is still large enough to bear reduction), the splitting up of holdings has been a cause of the increase of debt. The fact that the number of owners and the amount of debt have both increased more rapidly in most of these districts than in others, is at least presumptive evidence of this. In Jullundur, indeed, where there are nearly 10,000 more owners and share-holders than five years ago, and where the cultivated area has shrunk by 13,000 acres, it has probably been the determining factor, and perhaps explains why the increase in debt should have leapt up from less than two lakhs in the first half of the last decade to 26 lakhs in the last five years.

Expansion of cultivation.

Jullundur is one of the very few districts in which the cultivated area has declined. For the whole Punjab the last five years show an increase of over a million acres or $3\frac{3}{4}$ per cent. Much the greater part of this is due to the extension of canal irrigation. For canal cultivation more capital is needed than for dry. It is reasonable, therefore, to suppose that borrowing has taken place on this account. The effect of this upon an increase of debt may, however, be exaggerated. Thus none of the five * districts in which the expansion of cultivation exceeds 10 per cent. shows a remarkable increase of debt. Two of these, Mianwali and Dera Ghazi Khan, both Indus districts, while together adding 200,000 acres to their cultivated area, have not added more than 20 lakhs to their debt, which works out to Rs. 10 per acre. Moreover, in none of the districts in which debt has risen most, has the expansion exceeded 4 per cent. In three of them, the addition to cultivation is insignificant; and in one, Jullundur, there has been, as we have seen, a decrease. It would, therefore, be unwise to attach much importance to this factor. So far, however, as debt is due to an expansion of cultivation, it need not be regretted as it is productive debt.

Purchase of land on credit.

There is nothing dearer to the peasant proprietor than land. It is the alpha and omega of his life, and his only means of sustaining it. In a striking passage, Mill says: "When the habits of a people are such that their increase is never checked, but by the impossibility of obtaining a bare support, and when this support can only be obtained from land, all stipulations and agreements respecting the amount of rent are nominal. The competition for land makes the tenants undertake to pay more than it is possible they should pay." *Mutatis mutandis* this applies as much to the price of land as to its rent, and is one explanation why in the Punjab its price has more than doubled during the last 20 years. In the East, the primary

* Montgomery (39 p.c.), Multan (15 p.c.), Gujranwala (13 p.c.), Mianwali (12 p.c.), and D Ghazi Khan (10¼ p.c.).

value of land is social rather than commercial. It is one of the three things for which money is always forthcoming. The other two, of course, are a marriage and a case in the courts. All three are a common source of debt. We must, however, distinguish between the man who borrows to buy land which will yield enough to pay back both principal and interest and the man who borrows to buy it at an inflated price. The former is thoroughly business-like, but the latter is very much the reverse. Now that the price of land is abnormally high, borrowing to buy must, in nine cases out of ten, be thoroughly unprofitable. The purchase of land may, therefore, be an important cause of debt. On the other hand, as land is generally sold by one cultivator to another, it may be argued that the loss of the one being the other's gain, the net result upon total indebtedness should not be much affected. This would be truer if loans were repaid as readily as they are taken. Thus when, as must often happen, land is sold to meet debt, part of the price paid is probably retained for current expenses. If at the same time the purchaser has borrowed to buy, debt will increase more on the one side than it is reduced on the other. If this is correct we should expect to find the rise in indebtedness during the last five years accompanied by a rise in sales. This indeed is exactly what has happened. In the five years ending with 1912, land was sold for $7\frac{1}{2}$ crores, and in the last five years for 12 crores. There is, therefore, a rise of $4\frac{1}{2}$ crores, or an increase of 60 per cent. Turning to the figures for our nine districts we find the same feature. Lyallpur is the most striking case. In the earlier period, land was sold for 48 lakhs and mortgage debt increased by only one lakh, whereas for the last five years the figures are respectively 95 lakhs for sales and 43 lakhs increase of debt. The two are undoubtedly connected, and in the Civil Justice report of 1912 we read that "the acquisition of proprietary rights has left some of the Lyallpur zemindars short of ready money and they have sold or mortgaged their newly gained proprietary rights and decamped with the proceeds leaving debts behind them." In Ferozepore too a larger amount of land has been sold during the last ten years than in almost any district in the province, and, as we have seen, there is no district in which

indebtedness has increased more rapidly. On the other hand, large amounts of land have been sold in Multan and Gujranwala, which are not amongst our nine districts. Even in them, however, mortgage indebtedness has risen substantially during the last five years, the increase in each case being over 10 lakhs. It may, therefore, be concluded that land purchase and debt are connected, but the connexion is probably less marked in districts where money is plentiful.

High prices.

We come now to high prices. It is commonly assumed that they are good for the cultivator, as indeed they are if he has more to sell than to buy, but if it is the other way round, he benefits no more than any other class of consumer. In India a man with 20 or 30 acres will often have more to sell than to buy, and if his land is secured against bad harvests by irrigation high prices are an obvious advantage. The canal colonies have felt this to the full as is shown by the large amounts of gold which they continually absorb. But in districts where the average cultivated holding is six acres or less, it is only in years of good harvests that there is much surplus grain to sell, while in years of bad or unfavourable harvests, for part of the year at least, grain will probably be bought rather than sold. Let us compare for a moment two districts as dissimilar as Gurdaspur and Hissar, the one submontane with a good rainfall, the other officially described as " arid " with a rainfall of less than 15 inches. Going from the one to the other is like passing from a wilderness into a garden. At worst Gurdaspur will always have some appearance of cultivation. In Hissar, on the other hand, in a bad year it is possible to ride for 50 miles and hardly see a green thing. Yet the surprising thing is that in Hissar the people are undeniably better off than in Gurdaspur. They are better housed, better clothed and probably better fed. Even at the end of a year which has given only $3\frac{1}{2}$ inches of rain most people in Hissar had grain enough left in their bins to live on. Yet in November 1918, in Gurdaspur owing to a bad autumn harvest following upon a spring harvest which, though poor, was by no means a total failure, more people than not were buying grain (rice and maize) at Rs. 5 a maund.

The last and most telling point in the comparison is that debt in Gurdaspur is much higher than in Hissar. Thus if we take the Sirsa Tahsil of the latter and compare it with the Shakargarh Tahsil of the former, both being areas that are almost entirely dependent upon their rainfall, we find from enquiries recently made that in the Sirsa Tahsil the indebtedness of proprietors is about ten times the land revenue, while in the submontane Tahsil of Shakargarh the multiple is as much as 25. Further, in the former 26 per cent. of the proprietors are free of all debt, and in the latter only 3 per cent. One explanation of the difference is over-population, which neutralizes all the advantages of Nature. Hissar, with a cultivated area of $2\frac{3}{4}$ million acres, has to support a population of only 850,000, whereas to feed a slightly smaller population (837,000) Gurdaspur has only 833,000 acres. In Hissar, the average cultivated holding is 22 acres against 6 in Gurdaspur. In the former, therefore, a good year will produce a large surplus of grain which can either be stored against a bad year or be sold to great advantage. In Gurdaspur, this is generally impossible. It is not surprising, therefore, that it is one of the most heavily indebted districts in the Punjab, and it is significant that the only district which is more heavily mortgaged is the adjoining district of Sialkot where conditions are similar. High prices combined with poor harvests have accentuated the evils of over-population. And in this connection it has to be remembered that while the cultivator sells in a cheap market, as a retail purchaser he buys in a dear one. Accordingly as a consumer he feels the full effect of a rise in price, but as a producer he cannot gain its full advantage unless sale is co-operatively organized. This may explain why the last three years, which have all been years of war and abnormal prices, have seen so startling an increase of debt.

Facile credit.

A recent American writer on rural economics says that "farmers who do not keep accurate accounts and who have not a keen sense of values should avoid the use of credit as they would the plague." This is a counsel of perfection. All the world over the small proprietor, provident or improvident, must borrow. It is important,

therefore, that his credit should be both cheap and good. So far as it is only cheap it is a danger. It is the primary object of co-operative credit to secure that when credit is cheap it shall also be good and when good that it shall also be cheap. Where, however, the cultivator is left to himself, his credit will more often be cheap than good. The high value of his land makes borrowing a matter of ease, and the more valuable it becomes the more he is tempted to borrow. It was this that made an official of the Central Provinces write in 1889, "the owners of the land grow poorer, while their land is daily rising in value." Pope expresses the same idea when he says :—

"The devil's grown wiser than before;
He tempts by making rich, not making poor."

In the Punjab, Mr. Thorburn, to whose report we have already alluded, traces the beginnings of serious indebtedness to the seventies, when it became an easy matter to alienate land. Since then its value has steadily increased, notably in the last ten years, during which the price of cultivated land has risen from Rs. 75 an acre to Rs. 186, a rise of 148 per cent. In the same period debt has also increased enormously, and the theory may be hazarded that in a country of uneducated small proprietors, unless credit is controlled, debt will always rise in close ratio to land value, that in fact debt follows credit. In Sir Frederick Nicholson's well-known report on co-operation we read that even in so thrifty and educated a country as Switzerland an abnormal rise in land values led to the peasant proprietors becoming much more indebted, which shows, as Sir Frederick says, that "even in countries of good education the peasant proprietor cannot refrain from pledging any additional value which the land may acquire." The remark applies with double emphasis to India and its illiterate masses. To them a sudden rise in the value of land may be little short of a disaster. Yet official reports speak of it again and again as a matter for congratulation. Sir Bamfylde Fuller was nearer the mark when he wrote in 1889 that "money is practically never raised for the improvement of estates, and in almost every case the cause of debt has been improvidence and ignorance, pure and simple. In such a case a fall in the value of land as a means of raising money is one of the best

things that can happen." Applied to the Sikhs and Arains of the Punjab this is perhaps an over-statement. Over 14,000 wells, mostly masonry, have been sunk in the last five years. Several thousand improved implements have been sold, large tracts of waste land have been broken up, and there is evidence that in the more progressive districts the rudiments of improved agriculture are at last being grasped. But when all is said and done the money spent in this way probably represents but a very small part of the amount borrowed. While 14,000 wells have been sunk there has been an increase of 40,000 suits many of which must have cost the litigant much more than the price of a new well. With a person so incurably litigious as the Punjabi, it may be safely asserted that a substantial part of the money raised on the inflated value of land has been spent in the law courts. In the Civil Justice report of 1913, the increase in the number and value of land suits in Gujranwala is definitely ascribed to the cupidity aroused by the rising value of land. The same report states that in Jullundur practically every alienation is challenged, and the local District Judge adds expressively "the courts are the Monte Carlo of the peasant." That the connexion between debt and litigation is close is shown by the fact that year after year more suits are instituted in Muzaffargarh, Gurdaspur and Sialkot, which are probably the three most heavily indebted districts in the Punjab than in almost any other district in the province. Hoshiarpur and Amritsar run them close, and both are more heavily mortgaged than most districts. There can be no doubt that debt often follows litigation, and in the Punjab it looks as if litigation followed credit, the one increasing as the other expands.

Another common source of debt is ceremonial expenditure, especially of course upon marriages. It is difficult to collect statistics to prove this, but most cultivators will tell you that marriage costs more than it did. Twenty years ago, a peasant proprietor could get married for Rs. 100. Now Rs. 400 or Rs. 500 will hardly cover it, while amongst the Sikhs of the central districts, where the rise in indebtedness has been most marked, it will cost from Rs. 1,000 to Rs. 2,000. I know of a Zilahdar who, though Rs. 6,000 in debt,

spent Rs. 5,000 on a daughter's wedding. And last cold weather I came across a member of a co-operative society, who in 1916 spent Rs. 1,300 in marrying a son and the following year Rs. 400 in marrying a daughter. Together the two sums represented 17 years' rental of his ten-acre holding. And at the time he already owed over Rs. 1,500, most of which he had borrowed for a case. Instances of this kind are probably not uncommon, and they have doubtless multiplied since women became fewer than men. In short, borrowing for unproductive purposes is far too common in India.

We have now examined each of the seven causes to which the increase in indebtedness in the Punjab may be due. Superficial as the survey has been, certain tentative conclusions emerge. In the first place two factors stand out prominently, the great expansion of credit and the rise in prices. The former has probably operated throughout the province, the latter wherever holdings are small. Secondly, with these two main causes are interwoven others the precise importance of which it is difficult to determine as they vary in effect from district to district. Lastly, it is clear that further enquiry is needed, and it should be detailed and systematic. Prosperity and debt are evidently intimately connected ; and some of the accepted views in regard to the former would appear to need revision. If this is so, important consequences follow. One is that credit must be controlled. With a simple, uneducated and naturally improvident peasantry, it is clearly dangerous to let people borrow as they please. As a servant credit can turn sand into gold, but as a master it will turn gold into sand. Restriction, therefore, is necessary and co-operative credit is the obvious way of applying it, for members of a co-operative society cannot borrow at will. Moreover, through their society they learn the all important lessons of punctual repayment, honest dealing and thrift. Co-operation is indeed the very negation of indebtedness. In the Jullundur District I calculate that ten years of co-operation have reduced the net indebtedness of 20,000 members by 25 lakhs. No effort, therefore, and no expense should be spared to extend co-operative credit to every village that can be induced to accept it. Incidentally too co-operation is the best remedy for high prices.

Underlying the whole question of indebtedness in the Punjab is the problem of small holdings. We have seen that they are getting smaller and that this process is likely to continue, that they cannot resist bad seasons and suffer from high prices, and that in stimulating a demand for land they lead to its purchase on credit at an inflated value. The evil is clear but the remedy is difficult. The laws of inheritance can hardly be changed, nor is the Punjab well adapted to industries which would provide a subsidiary means of subsistence. The latter indeed need not be regretted, for no one who is acquainted with industrial conditions in India could wish the relatively healthy life of a country to be exchanged for the demoralizing influences of the town. There remain only two remedies : one is the improvement of agriculture so that production may keep pace with population, and the other is the encouragement of emigration. A good start with the former has been made by the Agricultural Department, but India is still far behind America and Western Europe in the effort made. Moreover, there are limits to what can be done, as small holdings and advanced agriculture do not agree very well together ; and in India the difficulty is accentuated by the climate which saps all desire for improvement. The alternative remedy, emigration, is therefore important. Before the war the Punjabi was more and more going to America and the Far East, and though he often returned a wealthy man—some have brought back nearly a lakh—he was not always a better man for the change. The war has happily provided an ideal colony for the future. In Mesopotamia, with its somewhat better climate than the Punjab, the sturdy qualities of our peasant proprietors should reach their fullest development. It is to be hoped, therefore, that this will not be lost sight of in the reconstruction that will follow peace with Turkey. The rural Punjab deserves well of its rulers ; and as the only martial province in India, anything that threatens its welfare is of more than usual importance. At present it is undoubtedly prosperous, but prosperity has brought debt. This anomaly should, if possible, be removed.

THE WHEAT PESTS PROBLEM.*

It is now well recognized that scientific research is of great money value, but it is not often that successful practical results follow so quickly upon research as in the recent campaign against the insect pests in the vast quantities of wheat which, owing to the war, accumulated in Australia. In this campaign, South Australia played a very important part.

In the early stages of the weevil plague, at the instance of Mr. G. G. Nicholls, Manager of the South Australian Wheat Scheme, a Wheat Weevil Committee was appointed consisting of Dr. W. A. Hargreaves, Director of the South Australian Department of Chemistry (Chairman), Mr. G. G. Nicholls, Mr. W. J. Spafford (Superintendent of Experimental Work, Department of Agriculture), Mr. A. M. Lea (Entomologist to the S. A. Museum), Mr. E. A. Badcock (Manager, S. A. Farmers Co-operative Union, Ltd.), and Mr. J. T. Jackett (Miller). Subsequently Mr. D. C. Winterbottom (Supervisor of Weevil Department in S. A. Wheat Scheme) was added to the Committee.

The work of scientific research on the subject was taken up by the Department of Chemistry, and from experiments conducted in the laboratory of that department three practical systems of treatment were devised. These, when put into use by the Wheat Boards in the States of South Australia, Victoria and Western Australia, resulted in saving wheat worth at least £1,500,000, besides giving very valuable knowledge on the whole problem of stored wheat which will be of service in the future.

This estimate of monetary value is an approximation. It is, however, based on the observation that the actual weevil damage

* Extracted from Report No. 2 of the State Advisory Council of Science and Industry of South Australia.

was at least reduced to one-half of what it would otherwise have been. Senator Russell, Chairman of the Australian Wheat Board, announced, on January 10th, 1920, that the actual weevil damage done to the wheat purchased by the British Government during the time it was held after purchase and before shipment had been assessed at 2,200,000 bushels, and that the British Government had agreed to pay the Australian Wheat Board the sum of £ 522,000 to cover this loss. This was based on the contract rate of 4*s.* 9*d.* per bushel. The amount paid for losses can be taken as a low estimate of the value of the wheat saved for the British Government. During the three years 1915-16, 1916-17, and 1917-18, the Commonwealth production of wheat was 404,000,000 bushels, of which South Australia contributed 98,000,000 and Victoria 136,000,000 bushels. The British Government contract was for 112,000,000 bushels, of which South Australia supplied 36,000,000 and Victoria 40,000,000 bushels, so that in round figures the British Government took about one quarter of the Commonwealth output, and this entailed about one-third of the output of South Australia and Victoria. The savings to each of the States of South Australia and Victoria can be taken then to be at least an equal amount to that saved for the British Government. Hence we arrive at the conservative estimate of £ 1,500,000 worth of wheat saved from destruction as the result of scientific research.

The following figures may help to demonstrate the extent of the undertaking as it affected South Australia, where the wheat had to be safeguarded from mice, weevils, etc.

The crop carried over from 1917-18 and in stacks was 42,000,000 bushels. The 1918 crop was 26,000,000 bushels, making a total of 68,000,000 bushels on hand. During the twelve months following only about 11,000,000 bushels were disposed of, leaving nearly 57,000,000 bushels to be carried over to 1918-19. The 1919 crop was over 20,000,000 bushels, and left no less than 77,000,000 bushels to be guarded.

Some idea of the magnitude of the work can also be gained from the following remarks made by Mr. R. A. Love, who was the

Australian Commissioner for the Royal Commission of Food Supplies in London :—

"The cleaning, sterilizing, and handling that had to be undertaken in Australia in connection with the wheat was without doubt the largest campaign of its sort that the world has ever had to undertake. When one considers the enormous amount of labour and the handling involved to enable the vast quantities to be cleaned, sterilized and made fit for shipment, it was truly colossal. In looking back over the work I think we can be proud of the results of our labours. It is nice to feel, considering the enormous amount of thought and worry put into the task, that it was successful in results, efficiency and cost.

"The gassing campaign without doubt saved an enormous amount of money, and enabled vast quantities of wheat to be held over until they could be treated."

The methods recommended by the Wheat Weevil Committee, as the result of the scientific research carried out by the Department of Chemistry, were the following :—

1. *Cleanliness.* The weevil was recognized as a pest which was fostered by careless and dirty conditions. Cleanliness in the collection, transport and storage of the wheat was, therefore, advocated. In storage the chief problem was to prevent contamination of the stacks from without. Hence the following precautions were enjoined :—Absolutely clean stacking sites, impervious insect proof floors, thorough cleaning up of old stacking sites, and gutters filled with water, oil, or molasses placed around the base of the stacks to prevent access of crawling weevils. Stacks were either enclosed in hessian and then limewashed or wherever practicable entirely enclosed in malthoid sheds. The malthoid sheds, first tried at the suggestion of Mr. A. M. Lea, a member of the Wheat Weevil Committee, proved the most successful.

2. *Gas treatment.* The use of poison gas for the extermination of vermin is by no means a new idea, and as far back as 1890 gas plants were used in South Australia for the purpose of suffocating rabbits in their burrows by means of air deprived of its free oxygen by being passed through a fire. During the mouse plague of 1916-17,

Dr. Hargreaves had suggested the use of a gas producer plant for providing large quantities of cheap gas for the extermination of mice, and in the middle of 1917, Mr. Saunders of Clutterbuck Bros., of Adelaide, experimented with producer gas as a means of destroying weevils, but these initial experiments were unsatisfactory, because the treatment was not continued nearly long enough. Carbon dioxide compressed in cylinders had been advocated in 1898 by Noel Paton, and in 1911, 1912 and 1913 by Barnes and Grove, but their methods were prohibitive on account of cost. It was not until the time factor was shown to be an important one, by experiments with weevils in closed bottles, carried out in January 1918 by Mr. Spafford, a member of the Committee, that gas treatment was found effective.

Mr. D. C. Winterbottom, Chemist in the Department of Chemistry, was transferred to the South Australian Wheat Scheme as officer supervising weevil destruction, and he installed the first gas plant in Australia. It was a decided success. Subsequently, other plants were installed by him in South Australia and Victoria, and similar plants were used in Western Australia. The operation of these gas plants in South Australia was placed in the hands of Messrs. S. D. Shield and E. A. Pengelly, research chemists of the Department of Chemistry, and in Victoria the plants were in charge of Mr. P. J. Thompson, of the Melbourne University.

The method employed was as follows :—The stacked grain was entirely enclosed in sheds covered with malthoid or similar material made as nearly air-tight as possible. Then air freed from free oxygen by being passed through a furnace similar to that of a gas producer, but producing carbon dioxide instead of carbon monoxide, was blown into the shed for three or four weeks to asphyxiate the insects. Many large stacks were thus successfully treated. In one case the stack contained 200,000 bags of wheat.

3. *Heat treatment.* In the cleaning and shipment of the weevilly wheat, heat treatment to a temperature of 140° or 150° Fahrenheit was found to be the most effective method of checking further outbreak of weevil. Soon after research was commenced in August 1917, Mr. Winterbottom found that this would probably

be a successful method, and experiments were made to see the effects of heat treatment on the wheat. It was proved that the flour and bread making properties were not impaired. A machine was invented in the Department of Chemistry and erected at Port Adelaide which killed all the insects passed through it without damaging the wheat. This was the first successful heat treatment plant in Australia.

Professor Lefroy was working on behalf of the British Commission in Sydney, and he investigated a large number of devices for destroying weevils, including a number of heat treatment machines designed by different inventors. He finally adopted the Poole and Steele Machine. At first this machine was not successful, but Dr. Hargreaves was able, as a result of experience gained by the research experiments, to suggest, at a conference in Sydney in March 1918, certain modifications which resulted in the successful working of the machine, which was then adopted by the British Commission.

The effects of this successful end to the investigations will be more far-reaching than they appear at first sight. Not only can the saving of the wheat stored during the war, which would otherwise have been destroyed by insect pests, be directly credited to scientific research, but the results obtained have demonstrated the practical value of the methods used. These methods can be used in future, so that the total money value of the research is beyond assessment.

A NEW PROCESS OF SEED SEPARATION.*

BY

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A NEW method of cleaning and grading seeds and grain has been invented and patented by Mr. E. D. Eddy, formerly Chief Seed Inspector of the Department of Agriculture, Canada. In the process of separation neither screens nor air currents are used, the separation being made entirely on the basis of comparative specific gravity. This is effected by subjecting the stock being treated to centrifugal action in the presence of a liquid which is of the specific gravity required for the separations desired. The patent claims include the following :—

" The method of separating grain and seeds into two grades or qualities, one lighter and one heavier, on the basis of comparative specific gravity by subjecting the same to a centrifugal action in the presence of a liquid having a density greater than the lighter grade and equal to or less than the density of the seeds or contained material composing the heavier grade ; the density of the liquid to be varied according to the separation desired."

The specific gravity of the liquid is varied according to the comparative weight of the seeds to be separated. A suitable material for making a liquid of the desired density is sodium nitrate but other substances may be used. With seeds weighing about sixty pounds per measured bushel, such as alfalfa and clovers, a solution of about 1·2 specific gravity is required. The best point of density varies with

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different kinds of seeds and the severity of the separation desired. By regulating the density of the liquid the proportion of the seeds which pass into the heavy and light separations is under perfect control. With clover seed, for instance, all weed seeds and other foreign matter, as well as shrunken, immature and light weight clover seeds of a lower specific gravity than the liquid are separated from those seeds which are as heavy as, or heavier than, the liquid. The proportion of clover seeds which will go into the light separation can be accurately regulated according to the character of the sample and the separation required.

The fact that most of the weed seeds commonly found in clover seeds are of a slightly less specific gravity than good clover seeds makes possible some remarkable separations by this process. With the ordinary methods of cleaning it is impossible to make a thorough separation of weed seeds from clover seeds if the former are approximately the same size as the clover seeds and closely similar in specific gravity. Cleaning this type of seed by screens and wind blast is far from thorough and involves a heavy loss of good seed. The advantages of the new process in such cases may be realized from the results of recent experiments made in the seed laboratory. Some of the results were secured with a small experimental machine and others with a machine designed for continuous work on a commercial scale.

Tests of several samples of red clover show a perfect separation of several kinds of the most common weed seeds classed as noxious under the Seed Control Act, including ragweed, Canada thistle, wild mustard, ox-eye daisy and stickseed, while others, such as ribgrass, campions and docks, were materially reduced. One lot of red clover screenings containing about one quarter ragweed seed, hulled and unhulled, was treated, and the cleaned seed was entirely free from ragweed with practically no loss of good seed. Almost equally valuable are the results in reducing the less harmful species including green foxtail which is the most common weed seed in red clover.

With alsike seed, perfect separations were made of false flax, Canada thistle, ox-eye daisy and unhulled timothy seed, while sheep

sorrel, foxtail and lambs quarters were almost entirely eliminated without material loss of good seed.

The results with alfalfa seed were especially promising, for they indicate that it may be possible to remove the weed seeds which have made it very difficult to produce clean seed in Western Canada and the Western States. The most troublesome weeds in alfalfa seed growing in the West are probably Russian thistle, stink-weed and wild mustard. At present it is almost impossible to procure alfalfa seed grown in Western Canada or the North-Western States which does not contain one or more of these weed seeds. Furthermore, in many cases they are present in such large numbers that even after heavy loss in cleaning, the alfalfa seed is almost unmarketable and its production unprofitable. One lot of alfalfa seed containing over two thousand stink-weed seeds per ounce was subjected to the new separation process and the cleaned seed was found entirely free from these weed seeds and there was no loss of alfalfa except a few light and shrunken seeds whose removal improved the sample. Equally good results were shown with a sample containing Russian thistle seed. Wild mustard was also readily separated from alfalfa as well as from the clovers.

In the case of timothy seed most samples consist of both hulled and unhulled seed which interferes somewhat with the removal of the weed seeds. With lots, however, containing only a small percentage of hulled seed some very effective separations of sheep sorrel, lambs quarters and other common weed seeds were made. A separation of perhaps more value for laboratory purposes than for commercial work is that of hulled from unhulled timothy seed. Numerous tests with different percentages of hulled seed showed perfect separation. That this separation is possible is evidence of the accuracy of the process in dividing samples on the specific gravity basis.

Tests so far made have been mostly with small seeds. It is expected, however, that valuable results will be secured also with grains by removing barley and oats from wheat, oats from barley, etc., in addition to the separation of weed seeds.

The process is, we understand, now being developed with the idea of putting it on a commercial basis. Should this be accomplished and the results obtained with seeds cleaned for general commerce be equal to those shown in the experimental tests, there should be a great improvement in the purity and general quality of the seed available, and the seed growing possibilities both for small seeds and seed grain will be greatly increased.

Notes

A SIMPLE POLLINATING APPARATUS.

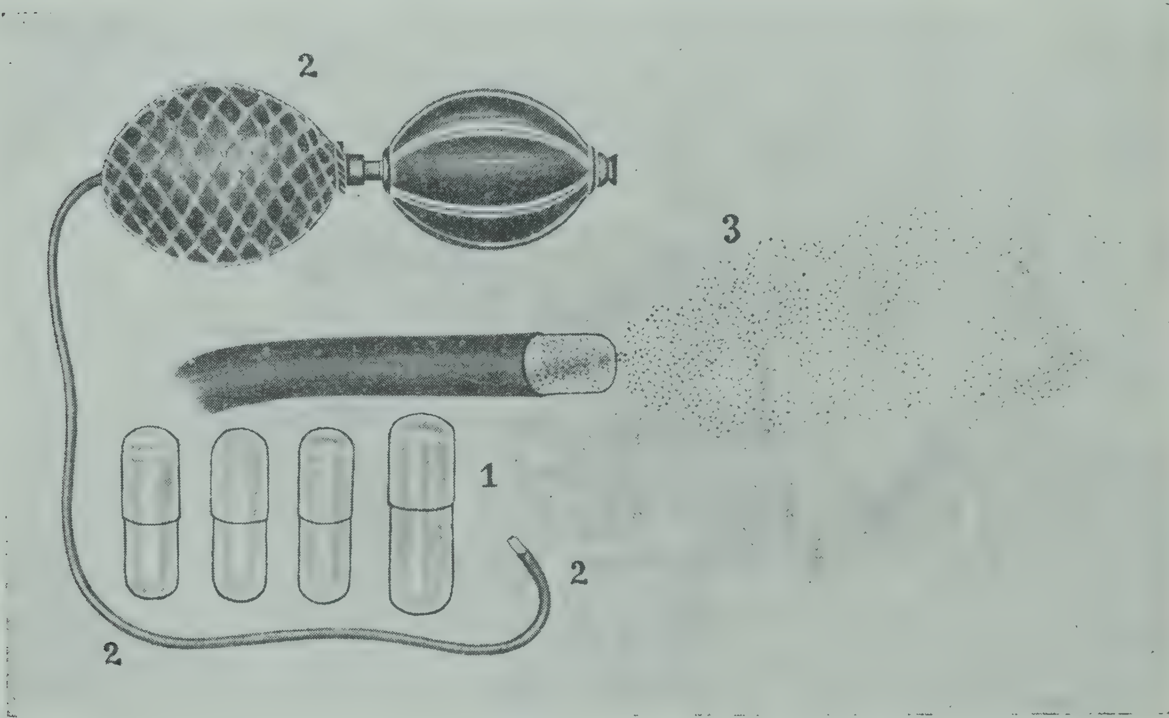
With the increasing recognition of the value of cross-pollination as means of producing superior strains of agricultural crops, repeated attempts are continuously being made to simplify the manipulations involved in the process. The "Botanical Gazette," for July 1919, describes an apparatus invented by Mr. Marie C. Coulter, of the University of Chicago, under the title "A Corn Pollinator."

The writer has been using, with considerable success and for over five years, an apparatus of his own design in the cross-pollination of sugarcanes at the Sugarcane-breeding Station, Coimbatore, and, as this would appear to possess certain distinct advantages, it is described below.

The pollen intended for crossing is collected from flowers bagged the previous evening, or early the same morning long before the anthers burst and shed the pollen. Tissue paper bags are used for the purpose. The collected pollen is passed through fine-meshed wire-gauze which would just allow the pollen to get through and free it from pieces of broken anthers or stigmas, often inevitable in such collections.

This sieved pollen is subsequently loaded into gelatine capsules (Text-fig., 1) available at any druggist's, where it is used to administer unpalatable medicines. Such capsules used to be available pre-war at twelve annas a hundred and are now to be had at twice the price. A slight moistening of the outer edge of the lower half, before the insertion of the lid, fastens them together and removes all risk of the pollen getting spilt in the subsequent handling. These are now treated as so many loaded cartridges and have been found very convenient to handle.

The arrow (sugarcane flower) to be cross-pollinated is now selected, the pollen-charged capsule inserted at the tube end of a "blowing ball" (Text-fig., 2), and two holes, one at the anterior



1. Gelatine capsules available at any druggist's for storing pollen.
2. A "blowing ball" showing the insertion of a pollen charged capsule at its tube end.
3. Showing the gentle spray of pollen as it emanates from the free end of the gelatine capsule when the blowing ball is operated.

and a second at the posterior end of the capsule, are made with one operation by passing a darning needle through, taking care not to puncture the india-rubber tubing in the process. When the bulb of the "blowing ball" is operated, a gentle spray, much like what happens in Nature when a sugarcane arrow is shaken by the wind or gently tapped, is given out at the free end of the capsule and can be directed to any portion of the arrow as desired. (Text-fig., 3.)

In the experience of the writer the following advantages have been noticed in favour of the apparatus described above :—

(1) The pollen spray is very gentle and closely resembles what takes place in Nature. The gentle spray conduces to economy of pollen, a great desideratum in the cross-pollination of sugarcanes.

(2) There is no risk of breakage and, as the capsules are sufficiently cheap to be thrown away each time after

use, there is no chance of a mix-up of different pollens at the time of crossing.

(3) No clogging is experienced in any portion of the apparatus, as the pollen is previously sieved.

(4) There is no risk of a blow back of the pollen, as the valve in the " blowing ball " allows the movement of air only in one direction, *viz.*, away from the free end of the capsule.

(5) Till the time it is actually needed, the pollen is stored away in what to all practical purposes are sealed receptacles, which minimizes chances of mistakes.

(6) The same apparatus can be used for a large number of cross-pollinations; all that is needed being a washing of the insertion end of the rubber tube, should any pollen be noticed at that end, whenever a fresh kind of pollen is used. This is rarely necessary if the operations are conducted with a certain amount of care and neatness.

(7) The height at which a particular pollination has to be done presents no special difficulties, as the outfit is light and compact. Sugarcane pollination has often to be done at a height of not less than 12 feet.

It should be mentioned, however, that, in very moist or dewy weather, the gelatine capsules become soft and the spraying becomes impossible. For the same reason the pollen, before loading, should be carefully freed from any adhering moisture, a usual condition when pollen has to be collected after rainy or dewy nights.

In all cross-pollination work it is essential that the pollen should be frequently and repeatedly tested for viability; as the conditions of storage, for however brief a period, or the inevitable manipulations, however carefully done, often greatly diminish or altogether destroy its vitality. It is reported that barley pollen loses its viability in about ten minutes in free air.

The artificial germination of pollen often presents considerable difficulties, and the interesting discovery has recently been made

that sugarcane pollen germinates freely on the stigmas of *Datura fastuosa* var. *alba.* This has rendered possible a series of experiments on the relative merits of different methods of storage of sugarcane pollen; and it has recently been found possible to keep sugarcane pollen viable for over seven days by preventing the dehiscence of the anther sacs. [T. S. VENKATRAMAN.]

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A VALUABLE CATTLE FODDER.

THE following further Bulletin on the usefulness of *baisurai* (*Pluchea lanceolata*) as a cattle fodder, by Dr. A. E. Parr and Babu Puttoo Lal, is being issued by the U. P. Department of Agriculture :—

Baisurai or *roshna* (*Pluchea lanceolata*) is a very troublesome farm weed in many parts of the United Provinces. It is particularly well known in the Agra Division and also occurs over large areas in the districts of Jaunpur and Benares. In the hot weather months, after the *rabi* crops are cut, it is so abundant as to appear like a crop on the ground. It is pre-eminently a weed of dry tracts as a deep root system enables it to live and thrive in the dry months when less deep-rooted plants die for want of moisture.

It has a peculiar taste, and on this account cattle carefully avoid it when grazing.

Experiments were begun some time ago to see if some use could be made of it as cattle fodder. A short account of the early results obtained by feeding a mixture of *bhusa* and *baisurai* at the Agra district farm has already been published.[1] Further experiments have been carried on at the Aligarh experiment farm. They have yielded very useful practical results, details of which will be found below.

The chief cattle fodder of a great part of the United Provinces, from the beginning of November until the *rabi* crops are harvested and threshed, consists of the dry stalks of *juar* (*Sorghum*). This does not form an ideal fodder. It is coarse and hard even soon after it is harvested and becomes more so after a few months of

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[1] *The Agri. Journ. India,* XVI, Pt. 1, p. 106.

storage. It contains only a small percentage of protein and has a large amount of indigestible ingredients. Analyses of *baisurai* show it to have a fairly high percentage of protein or flesh-forming material.

Experiments have now been carried on at Aligarh to see if young green *baisurai* would not be a valuable addition to dry *juar* stalks. The experiments have now been in progress for more than two months and have yielded very interesting results.

Seven bullocks were used for the experiment. Three of these were fed on *juar* stalks only. The other four were given a ration made up of half green *baisurai* and half *juar* stalks. Each bullock was fed separately and each animal got all the fodder he cared to eat. Each bullock was weighed daily and was given fairly regular work. The experiment began on the 1st November and the last weighing given in this note was made on January 6.

The weights of the various bullocks at the beginning and end of the experiment are given below :—

Name of bullock	Kind of fodder	Weight on 1st November		Weight on 6th January		Difference
		Mds.	Srs.	Mds.	Srs.	Srs.
Bissa wala A ..	*Juar* only	10	19	9	25	—34
Bissa wala B ..	Do.	10	29	10	22	—7
Atrauli A ..	Do.	7	3	6	33	—10
Atrauli B ..	*Baisurai* and *juar*	7	31	8	2	+11
Kishen Singh wala A ..	Do.	9	31	9	39	+ 8
Kishen Singh wala B ..	Do.	10	6	10	25	+19
Naubat wala ..	Do.	10	6	10	14	+ 8

It will be seen from the above table that in every case animals fed on *juar* fodder alone lost weight, while those fed on *juar* and *baisurai* gained in weight.

The figures indicate emphatically the value of the *baisurai-juar* mixture. But to any one experienced in animal management

the present condition of the bullocks themselves is even more striking. The animals fed on the mixture have a sleek well fed appearance. Those fed on *juar* alone have the staring dull coats which are always associated with animals not in a thriving condition.

Owing to the failure of the rains, fodder is very scarce this year, and there will probably be something approaching a fodder famine in some of the drier districts.

In the *baisurai* tract of the Agra Division alone, there are about 150,000 working bullocks. These could be fed on a quantity of green *baisurai* each day with a corresponding reduction of *juar* fodder, and probably later on of *bhusa*. During the next six months, that is during the period that fodder is likely to be scarce, in this tract alone *baisurai* could replace two million maunds of ordinary village fodder. This at present prices would mean a saving of roughly one-and-a-half million rupees.

The Agra Division instead of being short of fodder would have a surplus for sale elsewhere.

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PRICKLY PEAR AS FODDER FOR MILCH CATTLE

In India, prickly pear is not ordinarily used as a cattle food, but only during periods of famine when no other fodder is readily available. The cactus is roasted over a village forge and chopped fine before being given to the cattle in combination with *kadbi* (dry *Sorghum* stalks) or cotton seed. It will be remembered that during the last fodder famine in 1919 in the Bombay Presidency at one time as many as 34,000 cattle were feeding on this preparation in the district of Ahmednagar alone. In reviewing the work of cactus "kitchens" maintained by Government for famishing cattle, Lieut.-Col. G. K. Walker, Superintendent, Civil Veterinary Department, Bombay, remarked that "there can be no doubt that cattle can be maintained on prickly pear, when necessary, without harm." It, however, appears from the following extract taken from the "Journal of the Department of Agriculture, Union of South Africa" (Vol. I, No. 9), that prickly pear is not merely an emergency fodder, but is considered a valuable foodstuff for milch cattle which increases

the "quantity while maintaining the quality of the milk." "In Corsica and Sardinia, a daily ration of about 50 or 60 lb. per cow, comprising prickly pear finely cut up, mixed with bran or dry grass, was fed to impoverished cows, which had almost ceased their supplies, with good results. Mr. Martin, whose experience in feeding prickly pear to oxen has been quoted above, found his milk supply greatly augmented by utilizing prickly pear as a feed for his milch cows. In Mexico, milch cows maintained their yields, in spite of the increasing coldness of the season, when fed on prickly pear, thus minimizing the need of purchasing expensive winter fodders." [EDITOR.]

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THE MANURIAL VALUE OF COTTON BUSH.

THE following notes by the Acting Assistant Chemist of the Agricultural Department, St. Kitts-Nevis, are reproduced from the report on the Agricultural Department of that Presidency for the year 1918-19. The results of the experiments undertaken by Mr. Kelsick seem to justify his conclusion that the practice of burning cotton plants left on the land after picking the cotton is unadvisable, except for special reasons relating to the control of insect or fungus pests.

The practice of burning the remains of cotton plants left on the land after reaping has been, and still is, a general one in the cotton-growing islands in the West Indies, with the exception of St. Kitts where the bushes have always been buried under the banks.

The reason for burning, which is enforced by law in all West Indian cotton-growing islands, except St. Kitts and Nevis, was the eradication of insect and fungus pests, but in a paper by the Agricultural Superintendent, St. Kitts-Nevis, "Notes on the destruction of cotton bushes by burning" (*West Indian Bulletin*, Vol. XV, p. 319), it was pointed out that at La Guerite Experiment Station, where cotton was grown continuously, burying the bushes had been done instead of burning for some years with no increase of disease, and a change from burning to burying was strongly advocated.

The following notes have been written to show to what extent the fertility of the soil is being depleted in those islands where cotton bush is destroyed by burning.

In 1918, the bush remaining on the no-manure and pen-manure plots of the cotton manurial experiments was weighed after the crop had been reaped, with the following results :—

	No-manure lb.	Pen-manure lb.
Series 1	159½	234½
,, 2	148	254
Mean	153½	244½
Per acre	6,140	9,780

This amount of organic material might be considered small, but in tropical countries where the decay of organic matter is very rapid, and the supply of organic manures usually inadequate, any material which will help to maintain the humus content of the soil is valuable. It will, therefore, be seen that by burning the bushes there is an appreciable loss of useful material every year.

The amounts of nitrogen, phosphoric acid, and potash present in an average sample of this material was determined, and the following figures obtained :—

Nitrogen	2·16 per cent.
Phosphoric acid	1·40 ,, ,, (on air-dry material)
Potash	2·35 ,, ,,

These figures show that the bush has a high manurial value, and although some consideration must be given to the fact that it is returned to the land in a very undecomposed state, yet its value as a supply of potential plant food cannot be questioned.

The amount of manurial constituents removed annually from land yielding at the rate of 1,000 lb. of seed-cotton per acre would be about as follows :—

Nitrogen	26·32 lb. per acre.
Phosphoric acid	12·67 ,, ,, ,,
Potash	11·96 ,, ,, ,,

In computing these figures, use has been made of the figures given in the "West Indian Bulletin," Vol. V, for the composition of Sea Island cotton-seed.

The amount of manurial constituents returned to the soil by burying the remains of the plants would be about as follows:—

Nitrogen	... ...	171·9 lb. per acre
Phosphoric acid	... ...	111·44 ,, ,, ,,
Potash	... ...	187·1 ,, ,, ,,

It will, therefore, be seen that the amounts of nitrogen, phosphoric acid, and potash returned to the soil by burying the old plants are greatly in excess of those removed in the seed and lint.

Consideration of the foregoing facts makes it evident that the practice of burning the remains of cotton plants is detrimental to the fertility of the land. In the first place there is the loss of an appreciable amount of organic material, so essential for maintaining the fertility of tropical soils; and secondly, the land is deprived of a valuable supply of nitrogen.

The continuation of the practice must eventually lead to a state of unproductiveness, especially in the case of light soils, unless ample supplies of organic manures are available. [*Agricultural News*, No. 475, dated 10th July, 1920.]

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A NEW CANE-CUTTER.

A NEW cane-cutter, invented by Mr. John A. Paine, of the United Fruit Company's factory at Preston, Cuba, has recently been tested in Cuba with, it is said, satisfactory results.

The machine is of a large tractor type, weighing between 5 and 6 tons, and is propelled by gasolene-driven motor. It is capable of maintaining a speed of 6 miles per hour under favourable conditions. The inventor claims for it a capacity of cutting and handling 60 tons of cane per hour. The cutting is done by a 24-in. circular saw, fitted to a revolving shaft at the head of the machine and driven by a motor which is controlled by one man, who can adjust the position of the saw too high or low, to suit cutting conditions as desired. The harvesting arrangement provides for a series of grips which automatically catch the cane as it is being cut and remove the leaves by a stripping process, thence dropping the

stalks of cut and trimmed cane to a conveyor which carries them back and drops them to trailer cars following and drawn by the tractor. The automatic grips will work along the side of an extension and ahead of the cutter and following one row of cane, but in this first test of the machine these parts were not fitted, nor was the conveyor, so this article will not attempt to deal with the possibilities of these added harvesting improvements.

When it is considered a good day's work for one man to cut cane at the rate of 3 to 4 tons per day, it will be obvious, says the "Cuba Review" (to which the "Circular" is indebted for this information), that the economy and added production secured by this two-man cutter and harvester will be enormous, if it is finally proven to be the success now expected of it. The cutting principle is regarded as sound, and it was demonstrated without question that the saw will cut the cane at the level of the ground. [*The West India Committee Circular*, No. 576, dated 28th October, 1920.]

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GERMANS INCREASE CROPS BY FERTILIZING THE AIR.

THAT plants, through their leaves, feed upon the carbonic acid of the atmosphere, besides other elements taken up out of the soil, has long been known. But while the plant physiologists have hitherto studied the problem of increasing the production of crops by applying fertilizers to the soil, they have never thought it possible to get larger yields by fertilizing the air.

But that this latter is possible has been fully proved during the last three years by certain German chemists. Starting with the known fact that the carbonic acid contained in the air is slight—the average is said to be only 0·03 per cent.—they concluded that a considerable addition of that gas to the atmosphere should increase the growth in plants. They made experiments in that direction which are now described by Dr. F. Riedel in "Stahl und Eisen," the organ of the German iron industry.

It was well known to chemists that enormous quantities of carbonic acid are discharged from blast furnaces. But it is full of impurities. In particular it contains sulphur, and it has long been

observed that fields adjacent to blast furnaces bear poor crops as a consequence.

The chemists at one of the large German iron companies in the Essen district accordingly made experiments with gas purified of sulphur and duly diluted with air. Beginning in 1917, they used this purified carbonic acid in greenhouses, where it was distributed through punctured pipes.

The results were remarkable. Even after a few days the plants treated with gas showed a more vigorous growth than those in an adjacent greenhouse. They began to blossom earlier and their general development was much greater. The yield of tomatoes was increased 175 per cent. and cucumbers 70 per cent. At the same time experiments also were made in the open air on square plots around which punctured tubes were laid. Here an increase of 150 per cent. in yield of spinach was reached. 140 per cent. with potatoes, 134 per cent. with lupines (a legume), and 100 per cent. with barley.

Encouraged by these results, the chemists repeated the experiments in 1918 on a much larger scale, using a plot of 30,000 square meters. This time they got an increase of 130 per cent. with tomatoes, and even 300 per cent. with potatoes.

Other experiments proved that this fertilization of the air is far more effective than that of the soil, even though the latter be on a liberal scale. Fertilizing the soil alone gave an 18 per cent. increase; but soil and air fertilization together gave an 82 per cent. increase. The chemists do not regard the use of carbonic acid gas as a substitute for soil fertilization, but as an addition to it; both are necessary.

It is believed that this discovery will lead to very important results; it should make every agricultural region adjacent to furnaces enormous food producers. Dr. Riedel points out that a battery of furnaces producing 1,000 tons of pig iron a day consumes 1,100 tons of coke; also that the carbonic acid gas contained in the fumes from that coke could produce 4,000 tons of vegetable substance like potatoes, if it could be fully utilized. Of course, it cannot be fully utilized; but even if so low a figure as 10 per cent. of it can be

regularly converted into crop products this would be a result well worth striving for.

The discovery opens up a great possibility. May not the time come when from every blast furnace will radiate lines of piping for miles into the surrounding country ? Each farmer will then make his contract with the furnace to "turn on the gas" just as in the present irrigation regions water contracts are made. Of course, the gas must not be turned on too strong, for then it would injure the health of the farm labourers ; but, fortunately, it is not necessary to fertilize the air so strongly as to injure health. The danger point to health is considerably higher than would be required to insure a great increase in crops. [*Times-Pica-Yune,* dated 17th October, 1920.]

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LESS SEED : LIGHTER MANURING : GREATER YIELD.

A Paris correspondent of the "Manchester Guardian" states that considerable attention has been attracted to the agricultural methods of a farmer (M. Pion Gaud) in the province of Dauphine. It is asserted that were this farmer's methods adopted two-thirds of the grain now sown could be saved, which alone would be a saving of 4,000,000 quintals of cereals. In addition, there would be produced a further 20,000,000 quintals in France, if it can be shown that the method really gives the results claimed. This would enable France to export wheat instead of importing as at present.

The farmer, in describing his experiments, stated that in exhausted soil where in the preceding years oats could not be grown, he used only two-fifths of the quantity of grain that would be put in similar ground which was worked in the usual fashion. He manured with 3 lb. of sulphate of ammonia and 100 lb. of superphosphate, or 100 times less sulphate of ammonia and 100 times less superphosphate than his neighbours. He used no farm manure, and estimated his results at 25 per cent. more grain and straw than was obtained from similar grounds heavily manured and worked differently from his method.

His method of cultivation followed the lines advocated by Jethro Tull of over a century ago. By turning the soil eight or ten times the repeated aeration helped to penetrate the soil with the azote of the air, and so facilitated germination and augmented the production. He ploughed the soil from eight to ten times with a cultivator nearly two yards wide.

Following the lines of an Italian scientist, who is experimenting with the soaking of grain in a special solution which impregnates them with certain salts, he germinated the seeds in soots and nitrates. After soaking the grain in a solution, he placed it for several minutes in a bath of copper sulphate, the grain afterwards being placed in heaps until the warmth produced the beginnings of germination. It was then sown in lines an inch in depth, the machine sowing the superphosphates at the same time. The result was that immediately the plant took and pushed vigorously.

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DESTRUCTIVE INSECTS AND PESTS ACT.

THE following Notification has been issued by the Government of India in the Department of Revenue and Agriculture:—

In exercise of the powers conferred by sub-section (1) of section 3 of the Destructive Insects and Pests Act, 1914 (II of 1914), the Governor General in Council is pleased to direct that the following further amendments shall be made in the rules published with the notification of the Government of India in the Department of Revenue and Agriculture No. 13-C., dated the 7th November, 1917, namely:—

1. In rule 5 of the said rules, for the words "*Fomes semitostus* and *Sphærostilbe repens*" the words "*Fomes semitostus, Sphærostilbe repens* and *Fusicladium macrosporum*" shall be substituted.

2. In rules 7 and 9 of the said rules, after the word "Coffee" the words "and Hevea rubber" shall be inserted.

PERSONAL NOTES, APPOINTMENTS AND TRANSFERS, MEETINGS AND CONFERENCES, ETC.

We deeply regret to record the death of Mr. H. M. Chibber, M.A., Plant Breeding Expert to Government, Bombay, which took place in the evening of Saturday, the 1st January, 1921. Mr. Chibber had specially qualified himself for the post and had made a good start with his work on rice and wheat. His loss is much to be deplored.

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The New Year's Honours List contains the following names which will be of interest to the Agricultural Department :—

K.C.S.I. The Hon'ble Sir Edward Maclagan, K.C.I.E., C.S.I., Governor of the Punjab (sometime Secretary to the Government of India, Revenue and Agriculture Department).

The Hon'ble Sir Nicholas Beatson-Bell, K.C.I.E., C.S.I., Governor of Assam (sometime Director of Land Records and Agriculture, Eastern Bengal and Assam).

Mr. L. J. Kershaw, C.S.I., C.I.E., Secretary, Revenue and Statistics Department, India Office (sometime Secretary to the Government of India, Revenue and Agriculture Department).

C.I.E. Mr. D. T. Chadwick, I.C.S., Indian Trade Commissioner, London (sometime Director of Agriculture, Madras).

Mr. H. C. Sampson, B.Sc., Deputy Director of Agriculture, V & VII Circles, Madras Presidency.

Dr. E. J. Butler, M.B., F.L.S., Imperial Mycologist, Pusa.

Sardar Bahadur. Mr. Bhagwan Singh, Deputy Superintendent, Civil Veterinary Department, Burma.

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Mr. F. J. Warth, B.Sc., M.Sc., Agricultural Chemist, Burma, has been appointed to officiate as Imperial Agricultural Chemist, Pusa.

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Mr. R. Senior-White, F.E.S., has been placed on special work at Pusa from 1st November, 1920, to 28th February, 1921, to assist the Imperial Entomologist in sorting the collection of Diptera.

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Mr. G. R. Hilson, B.Sc., will in future be designated as Cotton Specialist instead of Economic Botanist for Cotton, Madras.

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Dr. R. V. Norris, Government Agricultural Chemist and Acting Principal, Agricultural College, Coimbatore, is granted combined leave for nine months.

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Mr. G. R. Hilson, B.Sc., Cotton Specialist, Coimbatore, is appointed to act as Principal, Agricultural College, Coimbatore, in addition to his own duties, during the absence of Dr. R. V. Norris on leave, or until further orders.

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Rao Sahib M. R. Ramaswami Sivan, B.A., Assistant Agricultural Chemist, is appointed to act as Government Agricultural Chemist, Madras, during the absence of Dr. R. . Norris on leave, until further orders.

His Majesty's Secretary of State has been pleased to appoint Mrs. Dorothy Norris as Government Bacteriologist, Madras.

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Mr. R. W. Littlewood has been appointed Deputy Director of Agriculture, Livestock, Madras, *vice* Mr. A. Carruth, resigned.

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Mr. W. J. Jenkins, who has been appointed Deputy Director of Agriculture, Bombay, has been placed temporarily in charge of the post of Plant Breeding Expert, *vice* Mr. H. M. Chibber, deceased.

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Mr. P. J. Kerr, M.R.C.V.S., Superintendent, Civil Veterinary Department, Bengal, is appointed to act as Second Imperial Officer, Bengal Veterinary College, in addition to his own duties.

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The University of Cambridge has conferred the degree of Sc. D. on Mr. H. M. Leake, who has also been appointed a member of the United Provinces Legislative Council.

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The Hon'ble Dr. H. M. Leake, Director of Agriculture, United Provinces, has been granted combined leave for one year.

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Mr. G. Clarke, F.I.C., Agricultural Chemist, United Provinces, is appointed to officiate as Director of Agriculture, *vice* the Hon'ble Dr. Leake on combined leave.

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Mr. T. R. Low has been appointed Deputy Director of Agriculture, United Provinces.

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Mr. W. N. Harvey, M.S.E.A.C., Deputy Director of Agriculture, United Provinces, has been granted an extension of leave for two months on medical certificate.

Captain W. H. Priston, F.R.C.V.S., has been appointed to the Indian Civil Veterinary Department, and posted to the United Provinces.

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Mr. C. A. Maclean has been appointed Deputy Director of Agriculture in Bihar and Orissa, and placed under training at Sipaya.

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Mr. D. P. Johnston has been appointed Deputy Director of Agriculture, Tirhut Circle, Bihar and Orissa, and posted at Sipaya.

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Mr. A. P. Cliff has been appointed Deputy Director of Agriculture, Chota Nagpur Circle, Bihar and Orissa, and posted at Ranchi.

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Mr. G. C. Sherrard, B. A., has been appointed, on return from leave, Professor of Agriculture, Sabour College, Bihar and Orissa.

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Mr. N. S. McGowan, B. A., Professor of Agriculture, Sabour College, has been appointed Deputy Director of Agriculture, Bhagalpur Circle, Bihar and Orissa, and posted at Sabour.

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Mr. H. W. Blake has been appointed Agricultural Engineer, Bihar and Orissa, with headquarters at Sabour.

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Dr. P. E. Lander and Mr. H. R. Stewart have been appointed Deputy Directors of Agriculture in the Punjab, and have been posted to the Agricultural College, Lyallpur, for training.

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Mr. T. A. Miller Brownlie, Agricultural Engineer, Punjab, has been granted furlough on medical certificate for six months.

CAPTAIN U. W. F. WALKER, Professor of Surgery, Punjab Veterinary College, Lahore, is appointed Professor of Sanitary Science, in addition to his own duties, relieving Captain K. J. S. Dowland, who has been posted under the Superintendent, Government Cattle Farm, Hissar, for training.

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CAPTAIN E. SEWELL, Post-Graduate Professor, Punjab Veterinary College, Lahore, has been attached to the office of the Chief Superintendent, Civil Veterinary Department, Punjab, Lahore, for training.

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THE LIEUTENANT-GOVERNOR OF BURMA has accepted the resignation of his appointment tendered by Mr. E. Thompstone, B.Sc., Deputy Director of Agriculture, Burma.

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MR. LESLIE LORD has been appointed Deputy Director of Agriculture, Burma, with headquarters at Mandalay.

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MR. J. CHARLTON has been appointed Agricultural Chemist, Burma, with headquarters at Mandalay.

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MR. T. RENNIE, M.R.C.V.S., Superintendent, Civil Veterinary Department, Burma, is appointed Veterinary Adviser to the Government of Burma.

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CAPTAIN ALBERT O'NEILL has been appointed Second Superintendent, Civil Veterinary Department, Burma.

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ON return from leave, Mr. R. G. ALLAN, M.A., has been reposted as Principal, Agricultural College, Nagpur.

On relief by Mr. Allan, Mr. F. J. Plymen, A. C. G. I., Principal, Agricultural College, Nagpur, has been appointed Agricultural Chemist to Government, Central Provinces.

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Mr. R. T. Pearl, B.Sc., has been appointed Mycologist to Government, Central Provinces.

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On relief by Mr. Pearl, the services of Mr. S. L. Ajrekar, B.A., Mycologist to Government, Central Provinces, have been replaced at the disposal of the Government of Bombay.

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Mr. S. T. D. Wallace, B.Sc., Assistant Director of Agriculture, Southern Circle, Central Provinces, has been appointed to officiate as Deputy Director of Agriculture in the same Circle.

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Mr. R. H. Hill has been appointed Assistant Director of Agriculture, Northern Circle, Central Provinces.

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Mr. J. C. McDougall has been appointed Assistant Director of Agriculture, Western Circle, Central Provinces.

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Mr. A. G. Birt, B.Sc., on return from leave, has been appointed Deputy Director of Agriculture, Assam Valley, and posted to Jorhat.

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Mr. J. N. Chakrabarty has been appointed, on probation, Deputy Director of Agriculture, Assam.

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Sectional Meetings of the Board of Agriculture being now a recognized part of departmental activities, Entomologists,

Mycologists, and Chemists and Bacteriologists assembled at Pusa for their fourth, third and second sessions, respectively, during the week beginning with Monday, the 7th February, 1921. As on the previous occasion, the meetings were not confined to members of the Agricultural Department, and were largely attended by scientific workers attached to other official and semi-official bodies. Several important subjects were on the agenda, and though the discussions were naturally of an informal character, some important and well-considered resolutions were adopted. The Proceedings will be published in due course and a fuller account given in the next issue of the Journal.

Reviews

Proceedings of the Bombay Provincial Board of Agriculture held at Poona, on the 9th and 10th June, 1920 [Bombay: Government Central Press.] Price, Annas 10.

The Hon'ble Mr. G. S. Curtis, C.S.I., I.C.S., Member of the Executive Council, Government of Bombay, presided over the meetings of the Board, which were attended by 29 members comprised of representatives of Agricultural, Revenue, Irrigation and Co-operative Departments, and a number of private gentlemen interested in agricultural development. The subjects discussed were :—

(1) A short report of technical results achieved up-to-date by the Agricultural Department.

(2) Programme of cotton improvement as laid before Government by the Director of Agriculture as a result of the report of the Indian Cotton Committee.

(3) The improvement of the manure supply in the intensively cultivated tracts of the Bombay Presidency, including the development of organization for advice as to manuring. The question of freight on manures.

(4) The question of organized attacks on definite plant diseases and of further investigation into them.

(5) The great prevalence of epizootic cattle diseases and the policy which should be adopted in regard to them.

(6) The development of agricultural propaganda and the part which (*a*) the co-operative movement, (*b*) agricultural associations and (*c*) district local boards can take in connection with it.

(7) The lines of development of education in vernacular both specially in agriculture and general in rural areas.

(8) The closer co-operation between the "development" departments (agriculture, co-operation, irrigation, sanitation, education, etc.) of Government and the methods by which it can be secured.

(9) The possibility and utility of establishing divisional boards of agriculture to discuss local problems and to be conducted in the vernacular.

(10) The future organization of the work of the Agricultural Engineer.

(11) The financing of the sale of pure and improved cotton by co-operative societies or otherwise.

Discussions were primarily based on notes on the various subjects submitted by the officers mainly concerned in them, and elicited a number of suggestions which will, no doubt, be of considerable help to the "development" departments (agriculture, veterinary, co-operative, etc.) of the province. On most of the subjects no formal resolutions were passed.

In dealing with the question of freight on manures, the Board unanimously resolved that "the Government of Bombay should be approached to ask Railway Companies to charge minimum rates of freight on the carriage of manures." It is well known that at present the freight is proportionately high in comparison with the cost price of manures, and tends to limit their use. The question of reduction in the freight on manures has, for sometime past, engaged the attention of the Agricultural Department and similar resolutions were passed at the Board of Agriculture in India, 1917, and later on at the First Meeting of Agricultural Chemists and Bacteriologists. 1919, with the result that the Agents of the various railways have been asked by the Government of India to give special consideration to applications by Local Governments for reduced rates.

It was agreed that District Boards of Agriculture should be held in the Presidency in order to bring local problems into greater prominence. [EDITOR.]

(1) **Poultry Keeping for Pleasure and Profit** AND (2) **Murghion ka Rakh-Rakhaw** (IN URDU) (**How to Keep Fowls**).—By Mrs. A. K. FAWKES, Poultry Expert to the United Provinces Government.

WE welcome in pamphlet form, both in English and Urdu, the very interesting series of 20 articles on poultry farming contributed by Mrs. A. K. Fawkes to the "U. P. Journal." They are written in studiously simple and untechnical language and are illustrated both by photographs and drawings. The pamphlets give instructions and advice on every aspect of poultry keeping which can be followed, without any additional trouble or expense and with much advantage, both by the professional who rears poultry for the market and the amateur who keeps fowls for domestic consumption. We hope the circulation of these pamphlets will achieve the desired result. [EDITOR.]

Correspondence

INFLUENCE OF STOCK ON SCION.

To The Editor,

The Agricultural Journal of India.

Sir,

While reading Mr. S. H. Prayag's article on the reciprocal influence of stock and scion, published in Vol. XV, Part V (1920), of "The Agricultural Journal of India," there occurred to me some points which, I think, might interest the author as well as other readers.

(*a*) The first point is in connection with the grafts between the different genera of the Anacardiaceæ of which he speaks on page 541 of the Journal. I have observed one case in Goa, where mango has been successfully grafted on *Spondias mangifera* (*Ambado*). The fruits of this graft were extremely sour and were, therefore, used only in pickles for which the fruits were much appreciated. I hear people in many parts of Goa also resort to this sort of grafting when they want sour fruits for their pickles. Such a grafted tree is known in Goa as *Amtoh*. As far as my observations go, a mango tree grafted on *Spondias mangifera* becomes dwarfed and short-lived.

In view of these facts, it seems to me that the failure of the grafts between the different genera in the Ganeshkhind Botanical Garden (Poona) was not due to any difference in the physiological activities of plants, but simply due to the fact that Poona has a climate which is not favourable to the grafting of anacardiaceous plants. For, from what I have heard and seen I can say that in Poona the mango grafts even on its different species do not establish as readily as they do in the Konkan or Goa. Again, the other plants of the same order which are mentioned on the same page do not thrive in Poona so well as they do in the Konkan and Goa. Hence

the chief reasons, I am inclined to think, why his attempts to make grafts between different genera of the Anacardiaceæ have met with failure in the Ganeshkhind Botanical Garden, are:

(1) The climate is not favourable for the luxuriant growth of the plants.

(2) The climate is such that even the inter-specific grafting of mangoes has not been very successful.

(3) The experiments made were extremely few.

Hence it will be worthwhile to repeat the experiments in places like Kanara and Goa—localities pre-eminently suited for the growing of anacardiaceous trees and making their grafts.

(*b*) The second point is about the grafting of *Chiku* (*Achras sapota*) on *Ryan* (*Mimusops hexandra*), also mentioned on the same page. There are persons in Bassein and Golwad (Thana District) who believe that the *Ryan*, or *Ranjant* as they call it, exerts an injurious influence on the *Chiku* scion in the direction mentioned by the writer. But my inquiries hitherto made go to show that they have no evidences to back their theory which, as far as I have been able to ascertain, is upheld only by some educated persons. The ignorant cultivators rarely graft *Chikus* and when they do, they do on *Chiku* stocks. Besides, most of those who believe in the above theory have also another one which is the converse of the above; every shy bearing *Chiku* must have been grafted on the *Ranjant*. The only case that they were able to cite in support of their belief was the one cited by Mr. P. G. Joshi, formerly the Curator of the late Bassein Botanical Garden, in "The Poona Agricultural College Magazine" (Vol. VI, Pt. 4). But his observations are not very conclusive since they were made on only one plant which might have been influenced in various other ways.

Hence it will be of extreme interest if Mr. Prayag were to make it clear as to the basis of his following statement: "it has been found by experience in Bassein garden that they (meaning the *Chiku* grafts on *Ranjant*) do not yield more than 15 fruits per tree."

College of Agriculture, Poona:
January 18, 1921.

Yours faithfully,
C. X. Furtado.

NEW BOOKS

ON AGRICULTURE AND ALLIED SUBJECTS

1. The Bases of Agricultural Practice and Economics in the United Provinces, India, by H. Martin Leake, M. A., Sc.D., F. L. S. (Cambridge : W. Heffer & Sons.) Price, 15*s.* net.
2. Lessons on Indian Agriculture, by D. Clouston, C.I.E., M. A., B. Sc. Illustrated. (London : Macmillan & Co.) Price, 3*s.* 6*d.*
3. Weeds of Farm Land, by Dr. Winifred E. Brenchley. Pp. x + 239. (London : Longmans, Green & Co.) Price, 12*s.* 6*d.* net.
4. Manual of Tropical and Subtropical Fruits : Excluding the Banana, Coconut, Pine apple, Citrus fruits, Olive and Fig, by W. Popenoe. (Rural Manuals.) Pp. xv+474+xxiv plates. (London : Macmillan & Co.) Price, 30*s.* net.
5. A Course of Practical Physiology for Agricultural Students, by J. Hammond and E. T. Halnan. Pp. 106. (Cambridge. At the University Press.) Price, 4*s.* 6*d.* net.
6. Text-Book of Pastoral and Agricultural Botany, by Prof. John W. Harshberger. Pp. xiii+294. (Philadelphia : P. Blakiston's Son & Co.) Price, 2 dollars.
7. A Text-Book of Plant Biology, by Prof. W. N. Jones and Dr. M. C. Rayner. Pp. viii+262+vi plates. (London : Methuen & Co.) Price, 7*s.*
8. An Introduction to the Structure and Reproduction of Plants, by Prof. F. E. Fritch and Dr. E. J. Salisbury. Pp. viii + 458. (London : G. Bell and Sons, Ltd.) Price, 15*s.* net.
9. Productive Soils. The Fundamentals of Successful Soil Management and Profitable Crop Production, by W. W. Weir.

Pp. xvi + 398. (Philadelphia and London: J. B. Lippincott Co.) Price, 10*s*. 6*d*. net.

10. A Farmer's Handbook: A Manual for Students and Beginners, by R. C. Andrew. Pp. xvi + 126 + xliv plates. (London: G. Bell and Sons, Ltd.) Price, 6*s*. net.
11. Laboratory Manual of Organic Chemistry, by Dr. H. L. Fisher. Pp. x+331. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd.) Price, 12*s*. 6*d*. net.
12. Agricultural Geology, by Dr. F. V. Emerson. Pp. xviii+319. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd.) Price 16*s*. 6*d*. net.
13. Root Development in the Grassland Formation: A Correlation of the Root Systems of Native Vegetation and Crop Plants, by Prof. J. E. Weaver. Pp. 151+Plates. (Washington: Carnegie Institution.)

The following publications have been issued by the Imperial Department of Agriculture since our last issue:—

Memoirs.

1. Studies in Diseases of the Jute Plant. (1) *Diplodia Corchori* Syd., by F. J. F. Shaw, D.Sc., A.R.C.S., F.L.S. (Botanical Series, Vol. XI, No. 2.) Price, Rs. 2 or 2*s*. 8*d*.
2. Morphology and Parasitism of *Acrothecium Penniseti* n. sp. (A new Disease of *Pennisetum typhoideum*), by Manoranjan Mitra, M.Sc. (Botanical Series, Vol. XI, No. 3.) Price, R. 1-4 or 2*s*.
3. Windrowing Sugarcane in the North-West Frontier Province. Part I.—The Effect on the Economical and Agricultural Situation, by W. Robertson Brown. Part II.—The Effect on the Composition of Sugarcane, by W. H. Harrison, D.Sc., and P. B. Sanyal, M.Sc. (Chemical Series, Vol. V, No. 10.) Price, As. 12 or 1*s*.
4. Life-histories of Indian Insects: Microlepidoptera, by T. Bainbrigge Fletcher, R.N., F.L.S., F.E.S., F.Z.S. (Entomological Series, Vol. VI, Nos. 1–9.) Price, Rs. 7-8 or 11*s*. 3*d*.

Indigo Publications.

1. The Conditions affecting the Quality of the Java Indigo Plant (Leaf Yield and Richness of the Leaf in Indigotin), by W. A. Davis, B.Sc., A.C.G.I. (Indigo Publication No. 7.) Price, As. 9.
2. Note on the Development of the Indigo Industry in Assam in conjunction with Tea and other Crops, by W. A. Davis, B.Sc., A.C.G.I. (Indigo Publication No. 8.) Price, As. 3.

Report.

1. Review of the Agricultural Operations in India, 1919-20. Price, R. 1-4.

THE PURPLE HONEY-SUCKER (*ARACHNECHTHRA ASIATICA*).

THE CATTLE EGRET (*BUBULCUS COROMANDUS.*)

Original Articles

SOME COMMON INDIAN BIRDS.

No. 4. THE CATTLE EGRET (*BUBULCUS COROMANDUS*).

BY

T. BAINBRIGGE FLETCHER, R.N., F.L.S., F.E.S., F.Z.S.,
Imperial Entomologist;

AND

C. M. INGLIS, M.B.O.U., F.Z.S.

MOST of the birds dealt with in these articles are of general occurrence and as likely to be found in Calcutta, or any other large town, as in the surrounding country-side, but the subject of our present paper seems to have little use for a town life, although it is one of the "common objects of the country" in most parts of the *mofussil.* According to Stuart Baker, in North Cachar it ascends the hills to 2,200 feet. The Cattle Egret (*Bubulcus coromandus*), as its popular name implies, is an Egret which is especially attached to cattle—frequently accompanying these animals and feeding on the grasshoppers and other insects disturbed as the cattle move about and also picking off insects, ticks and leeches which are attracted to the cattle. It is a very tame bird, even coming into compounds where any cattle are grazing. It is a social bird, generally occurring in parties, accompanying the cattle in the fields and frequently perching on their backs. Sometimes it attends pigs also and relieves them of lice. Occasionally it accompanies

crocodiles and apparently picks leeches or other parasites off them, and sometimes it varies its diet with small fish, tadpoles and aquatic insects. The late C. W. Mason investigated the stomach contents of three birds at Pusa in December 1909 and found that they contained 166 insects, of which three were Carabid beetles which were classed as beneficial, three as neutral, and 160 as injurious, the majority of this last category comprising grasshoppers and flies. There is no doubt but that this bird is decidedly beneficial to the agriculturist in India, not only helping to keep down grasshoppers and other crop-pests, but reducing the numbers of blood-sucking pests which prey upon cattle.

The Cattle Egret is easily recognizable, being a pure white bird with a yellow bill and black legs during most of the year. In the breeding season, which is at the beginning of the rains, some hair-like yellowish plumes grow from the head, neck and back, as seen in the right-hand figure of our Plate ; these nuptial plumes are orange-coloured on the head and neck, those on the back orange-buff varying to pinkish or brownish buff. In Bihar this plumage is assumed in April, but in the case of one colony which was breeding on some mango trees in August there were just as many birds in the pure white as in the usual breeding plumage.

Before legislation took place this Egret suffered the same fate as those with more valuable plumes, but now it appears to be much less molested. It is protected by law throughout the whole year in the Central Provinces, Bombay, Bihar and Orissa, United Provinces, Delhi, Madras, Burma, and Assam.

As noted above, the Cattle Egret is a social bird at normal times, contrary to the habit of most herons during the non-breeding season, and it is probable that this social trait is the direct result of its attendance upon cattle. At the breeding season, however, which is from June to August in regions watered by the South-West monsoon, November and December in the Carnatic, and April and May in Ceylon, this sociability is greatly accentuated and the Cattle Egret at this time breeds together in vast numbers, often in company with other Egrets, Pond Herons and similar marsh-loving birds, making a large untidy nest of sticks, built in a tree,

often in tamarind trees around village ponds, and laying three to five very pale greenish or bluish eggs, almost white, which vary much in size and shape but are typically rather broad ovals, somewhat pointed towards one end, and measuring on the average about 43 mm. long by 33 mm. broad.

Mr. J. MACKENNA, M.A., C.I.E., I.C.S.

BY

E. J. BUTLER, D.Sc., M.B., F.L.S.

On the 30th of April, 1920, Mr. J. Mackenna, M.A., C.I.E., I.C.S., vacated our editorial chair on his resignation of the post of Agricultural Adviser to the Government of India and Director of the Agricultural Research Institute, Pusa. By his resignation the "Agricultural Journal" has suffered a severe loss, and the Department has to regret the departure of a most distinguished and popular chief.

In his new appointment as Development Commissioner in Burma, he has taken up the highly responsible duties of the first post of the kind established in India, and it is gratifying to know that he will still remain in charge of the agricultural development of a considerable province of the Empire.

Mr. Mackenna's connection with the Agricultural Department extended over a period of 16 years from his first appointment as Director of Land Records and Agriculture, Burma, in 1904. Shortly after this, he attended the first meeting of the Board of Agriculture held at Pusa, in 1905, and, by his active participation in the discussions at this and subsequent meetings—he has attended nine of the eleven hitherto held and presided over three—has taken no small part in shaping the policy of the Department.

In Burma he was responsible for organising the Provincial Department of Agriculture which came into existence as a result of the policy of agricultural development initiated by Lord Curzon's Government in 1905. The first experts that started work on the

Photo by S. C. Ghosal,
Agricultural Research Institute, Pusa.

JAMES MACKENNA, M. A., C. I. E., I. C. S.,
Agricultural Adviser to the Government of India and ex-officio Editor,
"Agricultural Journal of India,"
1913-14 and 1916-20.

improvement of Burmese agriculture, with the advantage of Western experience, did so under his control, and it is fitting that, now that a large increase in expert staff of Burma has been sanctioned and a second period of progress is in sight, he should be back in his old province to exercise a guiding influence over the development of its resources.

He was first called to the charge of the Imperial Department of Agriculture in 1913, when he acted as Agricultural Adviser for a year during the absence of Mr. Coventry on leave. He returned to assume substantive charge when Mr. Coventry retired in 1916, and he held the post until his recent resignation, except for a short period of a month in 1918 when he acted as Secretary to the Government of India in the Department of Revenue and Agriculture, and for six months last year when he was on leave.

This period was one of exceptional strain in the agricultural as in all other departments. During the worst years of the war and the subsequent period of stagnation and slow recovery, the staff was depleted down to the bare minimum required to prevent disorganization. That in the face of these difficulties progress has not ceased is in no little degree due to the optimism with which Mr. Mackenna continued to consolidate the position already gained and prepare for a further advance as soon as conditions again became favourable. It was impossible to hope to expand during those years, but it was possible to prepare for accelerated progress in the brighter times that were coming. The end of the war found him with plans matured or maturing for a large expansion of activities in almost every direction and he had the satisfaction of placing these before Government during the past few months.

Post-war problems of great magnitude have to be faced in connection with some of our most important crops. The war very forcibly demonstrated the disadvantages of being dependent on foreign countries for supplies of the necessaries of life. Cotton and sugar are two of those commodities that the Empire produces in quantity insufficient for its needs, and in both cases India offers one of the most promising fields for development. Mr. Mackenna was instrumental in getting two strong committees appointed to

examine the Indian possibilities of expansion as regards these crops, and as President, first of the Indian Cotton Committee and then of the Indian Sugar Committee, he has spent a considerable part of the last three years in dealing with this question.

The Cotton Committee reported in 1918, and its recommendations have received a strong measure of support from bodies such as the Empire Cotton Growing Committee and the British Cotton Growers Association, as well as from the trade and agricultural authorities in India. They are far-reaching and will take a considerable time to give complete effect to, especially in the matter of securing the necessary staff to carry them out, but they are generally accepted as likely to be effective in improving the quantity and quality of the cotton grown in India.

The Sugar Committee was still sitting when Mr. Mackenna was summoned to Burma, and he had, therefore, to hand over its presidency to Mr. Noyce. Much of the Indian part of the enquiry was then completed and the evidence obtained is amply sufficient to show the need there was for a thorough examination of the position. Though India is one of the two chief producers in the world, there is little doubt that, but for the war, her imports of sugar would be now in excess of a million tons a year, and she is thus far from being in a position to feed herself, much less any other part of the Empire. But, with an area of some three million acres under the crop, it is clear that, if the Committee's recommendations are effective in stimulating the improvement of the present wretchedly low yield per acre, its work will have been of first-rate importance.

Another matter to which Mr. Mackenna devoted much attention was improving the publications of the Department. The "Journal" has greatly increased in popularity under his editorship and the recent decision to issue it every two months, instead of every quarter, should still further stimulate its circulation. His annual report on the Progress of Agriculture in India was regarded as, in many respects, a model for similar Government publications and was deservedly popular. In this connection, reference may also be made to his brochure on "Agriculture in India," where, in a

THE INDIAN SUGAR COMMITTEE.

FROM LEFT TO RIGHT, SEATED:—Mr. B. J. Padshah; Mr. F. Noyce, C. B. E., I. C. S., Vice-President, (now President in succession to Mr. Mackenna); Mr. J. Mackenna, C. I. E., I. C. S., President; Mr. J. W. Macdonald; Sirdar Jogendra Singh.

FROM LEFT TO RIGHT, STANDING:—Sir Frank Carter, Kt., C. I. E., C. B. E.; Mr. A. E. Gilliat, I. C. S., (Secretary); Mr. M. Wynne

little over a hundred pages, he gives a lucid and interesting account of the work of the agricultural and allied departments up to 1915.

At Pusa, Mr. Mackenna will long be remembered as the most genial and kindly of chiefs. He did much to improve the amenities of life, always difficult in such an isolated place, and showed a practical interest in regard to recreational, medical and educational facilities for the staff.

For the Indian Agricultural Service he worked hard to secure the revision of the terms of service that he held were long overdue. Though he was not himself a member of the Service, he had its interests at heart, and it owes a great deal to his representations on behalf of its members.

We hope that he will not forget his old friends in the Agricultural Department as we know they will not forget him. There may still be opportunities for an occasional meeting and we foresee a further increase in the popularity of Burma as a scene for the touring activities of the Pusa staff. The best wishes of the Department accompany Mr. and Mrs. Mackenna to Burma, where, we hope, they will have a very successful and happy time

PRINCIPAL FODDERS IN THE CENTRAL PROVINCES AND BERAR, INCLUDING THE SMALL BAMBOO (*DENDROCALAMUS STRICTUS*).*

BY

D. CLOUSTON, C.I.E. AND F. J. PLYMEN, A.C.G.I.,

Of the Department of Agriculture, Central Provinces and Berar.

THE improvement in the breeding of Indian cattle in order to raise the standard of animal at the disposal of the Indian agriculturist involves also improvement in animal management, particularly as regards feeding. Stall-feeding is not only becoming possible but also necessary in some tracts ; and in future the farmer will have to provide fodder for his cattle instead of depending upon indiscriminate grazing.

A series of analyses of the common grasses of the Central Provinces and Berar made in the department's laboratory some time ago showed that these grasses are fundamentally low in feeding value. The analyses are sufficiently interesting to be worth quoting.

Composition of common grasses of the Central Provinces and Berar.

Name of grass	Moisture	Oil, etc.	Total nitrogen protein*	Soluble carbo-hydrate	Crude fibre	Ash†	*Including true protein	†Including sand
Ischæmum sulcatum ..	7·38	1·38	3·56	35·75	35·35	16·58	3·19	14·59
Apluda varia ..	7·69	1·82	3·31	40·36	35·52	11·30	2·86	9·39
Setaria glauca ..	7·68	1·75	4·41	43·14	30·02	13·00	3·29	10·16
Iseilema laxum ..	1·16	1·25	2·89	46·98	31·13	10·59	2·41	8·30
Andropogon annulatus ..	10·34	1·76	2·69	43·57	33·18	8·46	2·00	5·33
,, *caricosus* ..	7·80	1·63	3·89	45·77	32·10	8·81	3·17	5·43
,, *pertusus* ..	10·57	1·83	3·95	47·48	28·62	7·55	2·39	3·93
Ischæmum laxum ..	8·84	1·20	2·97	42·82	34·01	10·16	2·35	8·06
Andropogon contortus ..	6·67	1·06	2·00	50·13	32·91	7·23	1·76	5·02
AVERAGE ..	8·24	1·52	3·30	44·00	32·54	10·41	2·60	7·80

* Paper read at the Seventh Indian Science Congress, Nagpur, 1920.

For purposes of comparison the following analyses of grasses grown in more temperate climates are given. The figures have been collected from various reliable sources.

	Ether extract	Total nitrogen as protein	Nitrogen free extract and soluble carbo-hydrate	Crude fibre	Ash
United States	3·14	9·21	53·97	25·71	7·97
Germany	2·34	10·74	46·53	34·09	6·30
Queensland	1·93	13·39	49·73	22·53	12·42
New South Wales ..	2·14	9·03	52·81	29·35	6·67

It is clear from a consideration of these figures that in so far as chemical analysis is a guide, the feeding value of Central Provinces and Berar grasses is much below that of the grasses produced in the countries named, particularly with regard to the highly important protein matter. Some of the local grasses have, however, a distinct reputation for feeding purposes, *Ischæmum sulcatum* being sufficient in itself to keep horses and cattle in good condition.

That present methods of chemical analysis are inadequate to deal with the relative values of pasture grasses is generally agreed. Figures given by Wilson[1] show practically no difference in the composition of grass from poor low rented pasture and that from valuable fattening land. Hall and Russell[2] arrive at the same conclusion in their study of the fattening pastures of Romney Marsh. More discriminating methods of analysis are obviously required, for although a food may contain a sufficiency of mixed protein, it is only of limited value if some necessary specific protein is absent. Further, the estimation of the digestibility of food is full of difficulties, and even when this factor has been determined more or less satisfactorily we are confronted with the question whether the digested portion of the food is entirely or only partially available for animal nutrition.

[1] *Science Progress*, Vol. VII, No. 27, p. 426.
[2] *Journ. Agri. Science*, Vol. IV, p. 339.

In considering the composition of Indian fodders, however, we are not at present dealing with the finer points of digestibility and availability so much as with the fact that in order to obtain its necessary daily ration of protein an animal has to consume about twice as much Indian fodder grass as would be required if the grass came from a more temperate country. It has been found that the quality of a fodder is susceptible to climatic changes, while Crowther and Ruston [1] in their investigation of the ripening of grass for hay found that poverty in protein was characteristic of fodder grown in dull cool weather.

In view of the apparent poverty of Indian grasses, any other fodders which can be grown easily are deserving of attention. Leguminous fodders are particularly valuable, even the wild bulky legume *Alysicarpus rugosus* has a total protein content of over 13 per cent. The cultivated leguminous fodders like lucerne (*Medicago sativa*), Egyptian clover or *berseem* (*Trifolium alexandrinum*), etc., are naturally of the greatest value where they can be grown, but the fact that they are not found to seed locally militates against their general adoption.

Of the bulky fodders commonly fed to cattle in the Central Provinces and Berar, rice and wheat straw and *juar* stalks are the most important. Many other fodders have been tested on Government farms in the provinces ; but with the exception of Egyptian clover (*Trifolium alexandrinum*) and the small bamboo (*Dendrocalamus strictus*) none of them has shown much promise of being suitable for adoption on a large scale. Egyptian clover or *berseem* does best when sown in rice fields about ten days or a fortnight before that crop is harvested. When the monsoon ceases in September, it does well when sown in a standing crop of early rice early in October ; but if the rains are more prolonged, it does better if sown later in fields carrying medium or late rice. To secure uniform germination it is all important that the seed should be sown while the surface soil is still damp. By lying in contact with moist soil the seed germinates in four or five days, and the young clover

[1] *Journ. Agri. Science*, Vol. IV, p. 305.

Fig. 1. Young bamboos three years after planting.

Fig. 2. Cattle being fed with bamboo leaves.

plant is well established in about ten days, by which time the rice can be harvested. Clover sown in standing rice does better than that sown in open fields which have had to be cultivated before sowing. This would appear to be due to the fact that in its early stages the young clover plant does better when shaded from the hot glare of an October sun.

The seed rate required for clover broadcasted in standing rice fields is 40 lb. per acre. Within six weeks from the time of sowing the crop attains a height of about 15 inches. If cut at this stage, there will be a second growth ready a month later. Cuttings of from three to four tons per acre can be obtained every month from December till April, if the land is kept slightly moist by irrigation. The best time to irrigate is immediately after cutting. It is very responsive to manuring and it has been observed that when its cultivation is continued on the same land its outturn increases gradually. This may be due to the increase of nitrogen-fixing bacteria in the soil, or to the manurial value of the roots left behind, or to both. As a fodder it is easily the best of those which have been tested up to date in the Central Provinces. If it were possible to raise seed locally, the crop would undoubtedly have a great future ; but under existing conditions the yield of seed per acre is only from 60 to 80 lb.

For poor light soils which cannot be irrigated, small bamboo (*D. strictus*) promises to be a most useful fodder, more especially in years of drought. Sir George Watt in his Dictionary of the Economic Products of India describes this bamboo as being densely tufted and gregarious, and as having strong and more or less solid culms of from 30 to 50 feet in height. It occurs on moderately dry hills throughout India and Burma, except in Northern and Eastern Bengal and Assam. It flowers after about 30 years ; and after flowering the plants die. This bamboo does very well on the poor gravelly soils of the rice tract of the Central Provinces where the rainfall ranges from about 45 to 60 inches per annum.

Plate XXI, fig. 1, shows the height attained in three years by bamboos grown on "mooram" soils on the Chandkhuri Farm, Raipur. The seedlings were raised in an irrigated nursery and planted out in

the beginning of the rains. The first cutting taken in June after three years' growth yielded 19½ tons of green fodder per acre which was much relished by the farm cattle as will be gathered from Plate XXI, fig. 2. Though the tender twigs and green leaves of the older culms were removed from time to time during the rains no apparent injury was done to the culms. From the outturns already obtained, there is reason to believe that yields of from 40 to 60 tons of leaf per acre can be obtained from this variety of bamboo three years after planting. The analyses of the leaf both in the dry and green state made by the Officiating Agricultural Chemist are given in the statement below. Some analyses of other locally grown fodders are also given.

TABLE II.

Name of fodder	Moisture	Ether extract	Total nitrogen as protein	Soluble carbo-hydrate	Crude fibre	Ash*	*Including sand
1. Bamboo leaves, green, *D. strictus* ..	66·07	0·97	6·34	12·75	9·45	4·42	3·58
2. Bamboo leaves, air-dry, *D. strictus* ..	7·80	2·22	12·93	38·06	24·18	14·81	12·05
3. Bamboo leaves, green, *B. arundinacea*	63·48	0·89	3·96	16·25	10·32	5·10	3·85
4. Bamboo leaves, air-dry, *B. arundinacea*	6·86	2·26	10·09	41·46	26·32	13·01	9·81
5. Lucerne, *Medicago sativa*, dry ..	6·09	2·02	15·20	43·30	23·83	9·56	0·53
6. Berseem, *T. alexandrinum*, green ..	81·63	0·51	3·22	8·26	4·00	2·38	0·15
7. *Juar* fodder, *Andropogon Sorghum*, dry	6·14	0·89	2·89	58·42	25·37	6·29	3·68
8. Average fodder grass, dry ..	8·24	1·52	3·30	44·00	32·54	10·41	7·80

It will be seen that of the most important constitutents of food, *viz.*, protein, oil and carbohydrate, dry bamboo leaves contain

nearly four times as much protein as is contained in the common grasses. The proportion of sand is somewhat high in both, and the proportion of indigestible fibre is greater in grasses than in bamboo leaves. The nutritive value of bamboo leaf appears to be at least equal to that of our grasses, while the yield obtained per acre is very much greater than that obtained from grass on similar soil. For the first cutting taken in June last year the variety *Dendrocalamus strictus* gave, as already pointed out, a yield of $19\frac{1}{2}$ tons per acre on the Chandkhuri Farm. Spear grass (*Andropogon contortus*), which is commonly found on this poor class of gravelly soil at present, ordinarily gives from $1\frac{1}{2}$ to 2 tons of green fodder per acre, which is equivalent to from 350 to 700 pounds of dry grass. It should be possible in parts of India where tracts of poor land are available and where the rainfall is suitable, to establish bamboo fodder reserves from which useful supplies of green fodder could be obtained for 7 or 8 months of the year, and from which bamboo hay could be made for utilization in years of fodder famine. That bamboo hay is a palatable fodder for cattle has been proved on the Telinkheri Dairy Farm, where an experiment is now being carried out to compare its feeding value with that of dry grass. In the green state it is already used as a fodder in certain parts of India. In this state it is supposed to possess medicinal properties and is commonly fed to ponies and cattle suffering from ailments such as "broken" wind and foot-and-mouth.

There are many other uses to which this bamboo could be put: its seed is a most welcome food-grain and its tender culms a welcome vegetable in famine years. Its mature culms are used as rafters and battens, or in the manufacture of mats and furniture. In jungly areas where bamboos are plentiful and where pigs abound, the cultivator fences his cane and vegetable plots with a fence made of split bamboos. There is, in short, good reason to believe that the systematic cultivation of this most useful species is well worth the serious consideration of the Department of Agriculture in this country.

SOME FACTS AND FIGURES REGARDING BANANA CULTIVATION.

BY

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AND

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The following facts and figures are culled from a mass of records of two plantations in the Ganeshkhind Botanical Garden, and may be of some use in giving more accurate information regarding this important crop.

Two varieties were used. In the first plantation was planted a variety locally known as *Soni*, with a medium-sized, very sweet, yellow-skinned fruit. The area of the plot was 23 *gunthas*, that is 23/40ths of an acre. The suckers were put in at 15 feet apart each way, and were 110 in number. The main objects of this plantation were to provide material for

(1) observation of the development and morphology of the inflorescence and flowers of the banana;

(2) study of the problems of pollination, fertilization, and hybridization.

Incidentally other observations were made or recorded in the cultivation sheets, and it is these that are here presented in a highly condensed form.

It should be mentioned that this work passed through the hands of no less than three assistants and hence there was some little trouble in disentangling facts from the records, but the statements now made are sound.

The plantation was destroyed in March 1919. The total yield of raw fruit for the plantation from June 1915 to this date was as follows:

	Yield	
	for 23 *gunthas*	calculated per acre
Weight	15,637 lb.	27,194 lb.
Number of fruits	81,066	140,984

The original sucker we called the mother-sucker, and the following suckers that came into bearing on the same stool we called the first, second, etc., sucker-generation. Suckers were cut away from the stool at first so as to leave one in bearing, one half-grown and one just starting. Later on this rule was not strictly observed. The total number of suckers that came into bearing during the time of the experiment was 494, representing the mother generation and up to three sucker generations after it.

The average yield per sucker (mother or daughter) during the period of experiment was 31·65 lb. in weight or 164 fruits in number.

A manurial experiment was carried out, the plot being divided into two, one part treated with a mixture recommended by Dr. Mann and the other receiving local treatment. Later on both plots received the same treatment. The following are the dates and methods of manuring, the quantities given are per stool:—

June 21, 1915 ..	Both plots received 80 lb. farmyard manure per stool, at time of planting.
June 26, 1916 ..	Sub-plot 1 received 20 lb. poudrette and 1 lb. Dr. Mann's formula, and Sub-plot 2, 40 lb. poudrette.
Jan. 11, 1917 ..	Do. Do. Do.
	(Manurial experiment ended.)
Feb. 9, 1917 ..	Both plots received 140 lb. farmyard manure and one lb. bone meal per stool.
June 1, 1917 ..	Do. Do. 100 lb. poudrette.
Jan. 23, 1918 ..	Do. Do. 100 lb. poudrette.

The manurial experiment has been recorded in the Annual Report of the Ganeshkhind Botanical Garden for the years 1915-16, 1916-17, and 1917-18 and in Bulletin No. 89 of the Bombay Agricultural Department. There is no need to say more of it here than to state that the poudrette plus Dr. Mann's formula proved the better treatment.

Watering was done at ten-day intervals.

The attached table is a record of the behaviours of three stools (numbers 14, 46, and 77) taken at random in the whole plantation.

Tree No.	Date of harvests	No. of days between harvests	Weight of fruit produced	No. of fruits produced	Fluctuation
			lb.		
14 mother	1-11-16	1 year and 130 days from planting.	18	130	..
A gen.	13-9-17	312	28	183	+53
B „	1-7-18	288	36	218	+35
46 mother	23-9-16	1 year and 92 days from planting.	24	154	..
Sister suckers { A gen.	15-5-17	232	31	172	+18
Sister suckers { A „	7-8-17	82	60	207	+35
Do. { B „	25-5-18	288	44	230	+23
Do. { B „	24-6-18	30	53	216	−14
77 mother	31-8-16	1 year and 70 days from planting.	8	104	
Do. { A gen.	5-4-17	215	48	248	144
Do. { A „	8-4-17	3	41	253	+5
Do. { A „	7-8-17	119	25	145	−108
Do. { B „	11-5-18	274	16	157	+ 12
Do. { B „	1-6-18	20	50	203	+ 46
Do. { B „	13-6-18	12	40	228	+ 25
Do. { B „	14-7-18	31	52	180	−48

On examining the above table we see that from the date of planting to the date of fruiting of the bunch the average

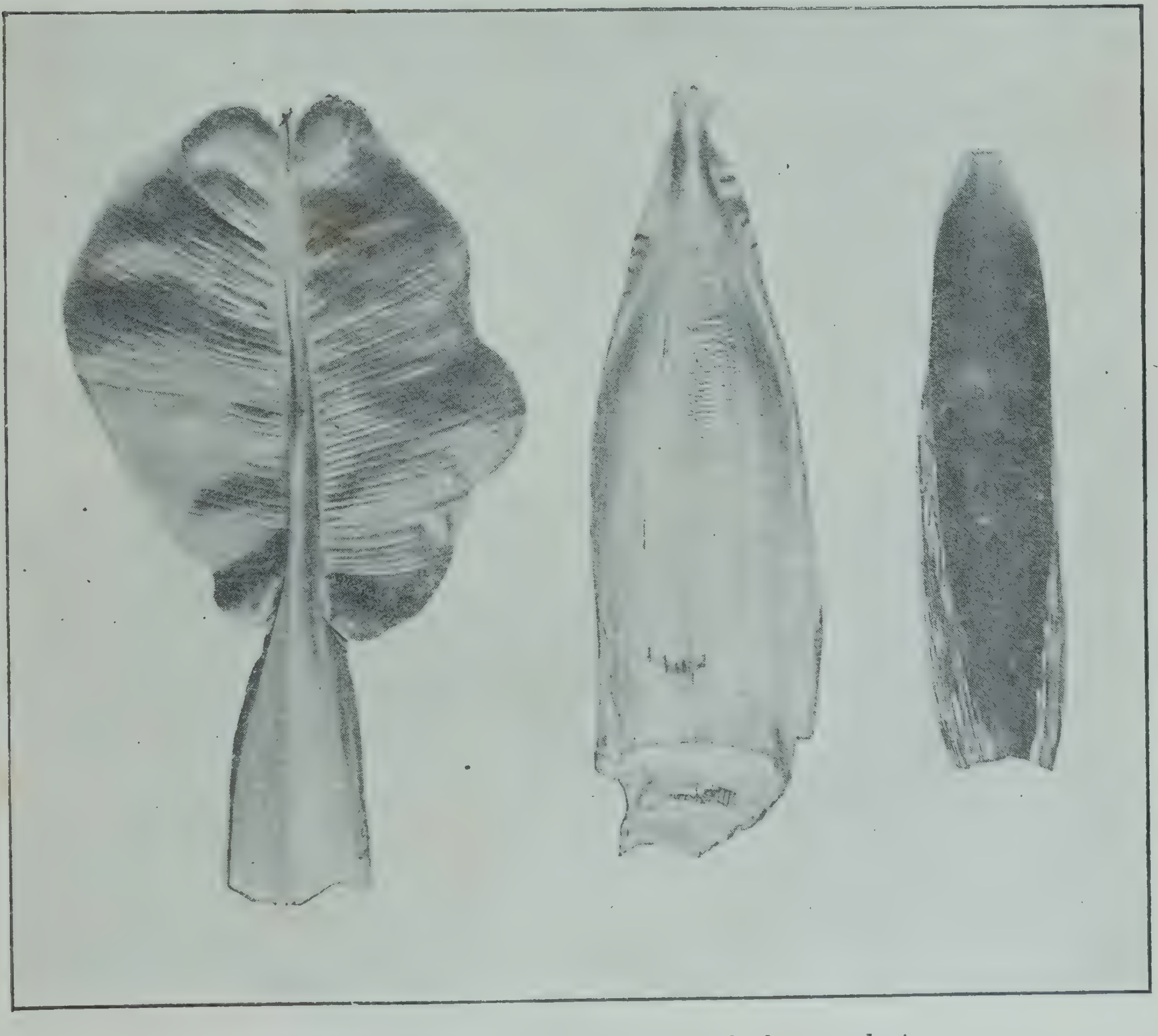
number of days required is one year, three months and seven days.

From the date of harvest of the mother to that of next generation the interval is 280 days.

The same from A to B is 298 days.

The yield in the first generation is more by an average of 72 fruits than that of the mother, and is still more by an average of 3 in the second generation than the first. (Here the average of three stools is taken.)

The appearance of the inflorescence is always heralded by the appearance of leaves which we have named *transition* leaves, intermediate between a foliage leaf and a bract. The text-figure shows their appearance.



Transition leaves 1 and 2, and first bract of a banana plant.

The average interval between the appearance of the first transition leaf and the harvesting of the bunch was as follows :—

	No. of trees averaged	No. of days
Mother generation	23	121
Sucker „	9	156
„ „	4	153
„ „	4	166

The second plantation consisted of plants of the *Rajeli* variety from Walhe village on the Madras and Southern Mahratta Railway. This variety is elsewhere known as *Rajapuri* or *Gujarathi.* This is a variety more dwarf in habit and with a more angled and slightly coarser fruit than *Soni.* The area planted was 8 *gunthas* (8/40ths of an acre) and the distance between trees each way was 11 feet. The total number of trees was 72. The plantation was begun on July 8, 1916, and destroyed in the beginning of March 1919.

The total yield for the whole plantation during its existence was :—

	Yield	
	for 8 *gunthas*	calculated for one acre
Weight	4,687 lb.	23,085 lb.
Number of fruits	17,210	86,050

The average number of sucker generations per stool was two.

The average yield per sucker was 21·27 lb. or 79·30 fruits.

The manurial treatment was as follows :

July 8, 1916 .. 50 lb. of poudrette per stool, at the time of planting.

June 1, 1917 .. 100 lb. of poudrette per stool.

Watering was done at ten-day intervals.

Taking three stools at random (Nos. 24, 32, and 49), the following are details regarding time of fruiting, etc :—

Tree No.	Date of harvest	No. of days between harvests	Weight of fruit produced	No. of fruits produced	Fluctuation
			lb.		
24 mother ..	31–7–17	1 year and 23 days from planting.	40	114	
A gen. ..	20–4–18	260	70	151	+37
B „ ..	5–8–18	105	29	130	−21
32 mother ..	25–8–17	1 year and 47 days from planting.	40	88	
A gen. ..	27–4–18	242	24	102	+14
B „ ..	10–9–18	133	18	79	−23
49 mother ..	13–9–17	1 year and 65 days from planting.	16	64	
A gen. ..	3–5–18	230	50	149	+85
B „ ..	21–2–19	288	19	62	−87

On examining the foregoing table we see that from the date of planting to the date of fruiting of the mother plant the average number of days required is one year and 45 days.

The interval between dates of successive harvests is—

an average of 244 days from mother to first generation, and
„ „ „ 119 „ „ first to second generation.

As to yield there is an average increase of 46 fruits in the first sucker generation and an average decrease of 44 fruits in the second generation.

The following calculations show the probable profits from the cultivation of the *Soni* variety in the Poona District.

Cost of cultivation.

Cost of labour :—man charged at the rate of 8 as. per day.
woman do. do. 4 as. do.
child do. do. 4 as. do.
bullock do. do. 4 as. do.

Farmyard manure at Rs. 2 per cart and poudrette at Rs. 2-4-0 per cart.

Two cart-loads are equal to one ton (2,240 lb.)

One basket is equivalent to 20 lb.

56 such baskets make one cart-load.

(The whole time of the existence of the plantation is taken as three years and six months. The following are calculated per acre.)

EXPENDITURE.

No.	Operations, &c.	Rs. A. P.
1	Two ploughings crosswise by an iron plough CT_2 or Arlington, two pairs and two men for 4 days	8 0 0
2	Disking and harrowing, one pair and one man for the whole day ..	1 8 0
3	Digging pits; size 2½′ × 2½′ × 2½′. Pits required for an acre 15 feet apart are 193. One man digs 5 pits in one day, 39 men finish the work in one day	19 8 0
4	Suckers required 200, at the rate of Rs. 10 per 100	20 0 0
5	Manuring at the time of planting, F. Y. M. 80 lb. per plant (14 cart-loads required)	28 0 0
6	Carting manure at R. 1 per cart	14 0 0
7	Planting suckers; one man plants about 25 suckers in one day ..	4 0 0
8	Harrowing and levelling after planting	1 0 0
9	Preparation of beds and water channels, one man prepares about 16 beds of the size required per day	6 0 0
10	Irrigation charges :—water generally given for 10 months in a year excepting rainy season; 30 waterings in all for one year. Irrigation Department charges per acre Rs. 22-8-0 for crop like plantain (G. R. No. 6371, dated 27th June, 1917), for three and half years ..	78 12 0
11	Watering charges; in all 105 waterings for the whole time of the plantation; one man can irrigate one acre in a day	52 8 0
12	Stirring, digging and weeding the beds once every three months. 12 men can finish it in one day. 14 such operations	84 0 0
13	MANURING :—Generally manured every six months. For the method of manuring as described above on page 387 the total cost comes to..	173 10 0
14	Land assessment to Government for three years at the rate of Rs. 4 per acre	12 0 0
15	Rent of land on lease for three and half years at the rate of Rs. 20 per acre	70 0 0
16	Harvesting charges; per bunch 3 pies, for 868 bunches	13 9 0
	Total cost ..	586 7 0
	INCOME.	
	Yield per acre in number of fruits, 140,984; sold wholesale on the plot itself at Rs. 10 per 1,000	1,409 13 0
	Subcrop like chillies, etc., taken for the first six months. The net profit per acre for such a crop comes to..	50 0 0
	Spare suckers sold at the rate of Rs. 10 per 100	52 0 0
	Total income ..	1,511 13 0
	Deducting cost of cultivation ..	586 7 0
	We get a net profit for three and half years ..	925 6 0
	So, for one year, the net profit for banana cultivation is ..	265 0 0

SOME NOTES ON COTTON IN SIND.

BY

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The economic significance of natural crossing is a matter of the first importance, as it affects the improvement and introduction of varieties and also distribution of seed. Hence it is worth while to estimate the extent to which it occurs and also to find out an efficient means of protection against it. Professor Gammie, from the failure of emasculated flowers exposed to natural crossing to fertilize, was led to believe that Indian cottons were normally self-fertilized, but the most reliable method of obtaining accurate information on the subject should be based on a study of single plant cultures.

During the course of the writer's selection work on the local cotton (*Gossypium neglectum*) in Sind, he has been dealing with a large number of single plant cultures for the last few years, and the record of the examination of their progeny may give a clue to the present inquiry. The local cotton in Sind is composed of four varieties, two with white flowers, namely, (1) *Neglectum rosea* and (2) *Neglectum cutchica*, and two with yellow flowers, namely, (3) *Neglectum vera* and (4) *Neglectum malvensis*. It has been shown by Leake and corroborated by Fyson that white colour of the petals in the cotton flower is recessive while yellow is dominant. If that is so, the extent of natural crossing can be determined with certainty from the behaviour of the progeny of the white-flowered plants exposed to natural crossing; while the examination of the progeny of the yellow-flowered plants will not help much, as the

first generation hybrids always assume the dominant form and thus escape detection.

In the year 1915-16, sixty-four white-flowered plants were marked in an ordinary field where all forms were growing mixed. Each was picked separately, sown next season in line culture and the progeny examined. Three cultures were lost and the detailed results of the remaining sixty-one cultures may be summarized as under :—

Variety	No. of single plant cultures	No. of cultures breeding true to type	No. of cultures splitting	Percentage of plants affected by natural crossing
Neglectum rosea ..	34	6	28	84
Neglectum cutchica ..	27	8	19	70

In the year 1916-17, fifty white-flowered plants were similarly marked in a mixed field, separately picked and sown next season in line cultures. The detailed results of the examination of the progeny are summarized as under :—

Variety	No. of single plant cultures	No. of cultures breeding true to type	No. of cultures splitting	Percentage of plants affected by natural crossing
Neglectum rosea ..	28	6	22	79
Neglectum cutchica ..	22	5	17	77

Similarly, the selection of ninety-nine white-flowered plants in the year 1917-18, sown next season, gave us the following results :—

Variety	No. of single plant cultures	No. of cultures breeding true to type	No. of cultures splitting	Percentage of plants affected by natural crossing
Neglectum rosea ..	49	19	30	60
Neglectum cutchica ..	50	14	36	72

The results of the selection of 1918-19 are as under :—

Variety	No. of single plant cultures	No. of cultures breeding true to type	No. of cultures splitting	Percentage of plants affected by natural crossing
Neglectum rosea ..	36	16	20	55
Neglectum cutchica ..	10	5	5	50

The results show that vicinism causes from 50 to 84 per cent. of the plants to become affected by natural cross-fertilization. The percentage would be still higher if we were to take into consideration fertilization between sister plants which remain undetected. It has been further found that one plant bears on an average twenty flowers and that the affected plant gets on an average two of its flowers naturally crossed. At that rate the percentage of natural cross-fertilization would amount to from 5 to 8·5 per cent.

Since natural crossing is annually occurring and is a permanent source of trouble, confusion, and error, any practical means of protection against it would be simply invaluable not only from economic considerations, but also in solving genetic problems. In all line cultures, specially in Mendelian work, covering of the plants or the flowèrs is an absolute necessity. Several devices are resorted to, such as paper covers, muslin bags, nets, rings, sutures, etc. Whatever the device, the labour involved is considerable and there is always a certain percentage of flowers that do not set. Further, Mr. Leake found that the effect of continued covering leads to sterility. Apart from this, the application of these devices is limited to small cultures, being of no avail for cultivation on a field scale where roguing and insolation are the only means of protection.

During the course of the writer's observations on the cotton flower he chanced upon a flower which was marked (among several others) at 10 o'clock in the morning, when it was a full bud, for the purpose of recording the exact time when it would open. After two hours the bud was very much swollen but the tip was

completely sealed, maintaining the shape of the bud, while other flowers had opened their petals wide apart. The particular flower was kept under observation, every hour until evening, but the petals never opened; the bud began to shrivel from 2 o'clock, showing that fertilization had taken place inside. Observations were continued till the next day, but the petals did not open as was expected from the shrivelled appearance of the closed petals on the previous day. It was then properly marked and labelled for collection of seed. When the boll was formed a small bag was put on lest cotton should drop on the ground when the boll burst. The same evening while rambling in his cotton plots the writer found some fertilized flowers with closed petals as distinct from those that had opened as usual. The circumstances led to the search of some more cleistogamic flowers and the writer was able to find about a dozen and a half on which observations were taken during the full course of a day. It may be further remarked that the plants on which cleistogamic flowers were discovered had mostly opened all the flowers except the one closed flower that was found. The case is analogous to that of Nilsson who discovered that in pure lines of oats occasional grains appear that are aberrant either in colour or morphological characters. The variations tested by him either bred true at once, or after one or two generations practically all of the progeny bred true to the character.

Now it remains to be seen if this character is hereditary or if it can be fixed. The very existence of cleistogamic flower suggests that a race could be bred in which the flowers would admit no crossing. In conclusion, the writer is reminded of a passage from Balls who, while describing the various means of protection against natural crossing, says:—

> "Another obvious possibility is the discovery or manufacture of a cleistogamic flower which shall absolutely refuse to admit foreign pollen to its style. At one stage of these researches the author seemed to be well on the road to success in this direction and the story of ultimate failure is not without suggestiveness."

Failing to find anywhere a hint of the existence of uncrossable cotton flowers, Balls was led to experiment on a short style flower in which the opportunity of foreign pollen to reach the style was small, and came to the conclusion that the accessibility of the style was a minor factor in natural crossing under the conditions of our breeding plot.

STUDIES IN BIOCHEMICAL DECOMPOSITION OF COW-DUNG AND URINE IN SOIL.*

BY

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In a previous paper on nitrification of green manures, read at the last Science Congress, by the writer, it was shown that certain plant tissues, *e.g.*, stems and roots, fail to nitrify in soil, even under optimum conditions of temperature and moisture, and also as a result of further experiments it was suggested that "the failure to nitrify, so far as ascertained, does not depend on the nature of the nitrogenous materials. It is probably due to nitrate reduction occurring in the presence of great quantities of non-nitrogenous materials, such as cellulose and woody tissue." In order to find out whether and, if so, how far this explanation is applicable in the case of other organic nitrogenous materials, experiments with a number of different manures like oil-cakes, cattle-dung and urine, and sheep-fold manure, etc., were initiated, but as it would unduly lengthen the paper if we were to deal with all the substances examined at one time, it is proposed here chiefly to deal with the trials made separately with cattle-dung and urine only. These two materials are of the greatest importance to the agriculturist, especially in India, as they form principally the only sources of manure to the small cultivator in this country where practically no artificial manures or oil-cakes are employed in the usual farm practice, except by planters or rich cultivators. It will perhaps be asked at the outset why experiments with farmyard manure direct were not so far carried out, since farmyard manure

* Paper read at the Seventh Indian Science Congress, Nagpur, 1920.

is the most commonly used manure all over the world, and both the materials experimented with, *viz.*, cattle-dung and urine, are associated together in the farmyard manure as its chief constituents. It may be pointed out, however, in reply that the work on farmyard manure is complicated by the fact that this manure undergoes several chemical and bacterial changes during storage and further the quantities of dung and urine which are added in different places while making up the farmyard manure are subject to such a wide variation that no useful purpose would have been served by taking up the study of farmyard manure at once ; especially as it was considered that more useful information could be obtained by studying, in the first instance, the decomposition of the two materials—dung and urine—separately, either before or after fermentation. Besides, the study of the decomposition of these substances separately was more suited to our purpose as the difference in the chemical composition of these substances is already known. The urine of animals contains nearly all the potash and a good deal of nitrogen with only a very small amount of phosphate, while the non-nitrogenous material present is very much smaller as compared with dung which contains a proportionately larger amount of non-nitrogenous materials. The amount of phosphate voided with the dung is also comparatively larger. Moreover, the urine contains the plant foods not in solid form as in the case of the dung, but in solution. It was therefore proposed to see in the first instance which of these two substances in a fresh condition, *i.e.*, before fermentation, is more easily nitrified, as the knowledge whether any particular organic substance would readily decompose in a soil so as to be immediately available to the crop is likely to be very useful to the agriculturist.

The study of the decomposition of these substances after they were separately stored and had undergone fermentation was also further taken up as it was considered to be of practical value from the point of view of conservation of farmyard manure. Owing to fermentation and drainage, the loss from the manure kept in the ordinary way is a very serious item, and the problem of conservation of farmyard manure would be much simplified if it were

known which of these substances is responsible for the serious losses known to occur during storage of this manure. Although it is doubtful whether such a study will confer immediate benefits or solve the problem at once, the writer was led to undertake the investigation in the hope of getting some useful data. The results so obtained form the subject matter of the present paper and are presented here with a view to elicit useful criticism.

While studying the nitrification of cattle-dung and urine, it was the writer's original intention to study and compare the decomposition of sheep-dung and urine, but it was not possible to arrange to get these separately. Only sheep-fold manure (*i.e.*, a mixture of dung and urine) was available. Trials with this are included here just to indicate what kind of results can be expected with the mixture of dung and urine obtained.

Cow-dung and urine and sheep-fold manure were brought to the laboratory in fresh condition and were immediately analysed for their moisture and nitrogen content. These being determined, they were then separately added to each kilo of air-dry Pusa soil at the rate of 30 mgm. of organic nitrogen per 100 grm. of dry soil (equivalent to 750 lb. of N per nine inch acre), water was added so as to make up the moisture content of the soil up to 16 per cent., allowance being made for the water already contained in the manures. The manures were then thoroughly mixed with the hand and each lot filled in separate glass bottles covered and kept at 30° C. in the incubator. It would be useful here to mention that the quantities of nitrogen and moisture stated above had been found to be optimum for the Pusa soil for nitrification and were therefore adopted in these experiments.

Samples for analysis were taken after thoroughly mixing the soil, to determine quantitatively the amount of ammonia, nitrite and nitrate formed at the end of each week for the first four weeks, after which time determinations were made at an interval of two weeks.

The methods of analysis were the same as those employed on the previous occasion.[1]

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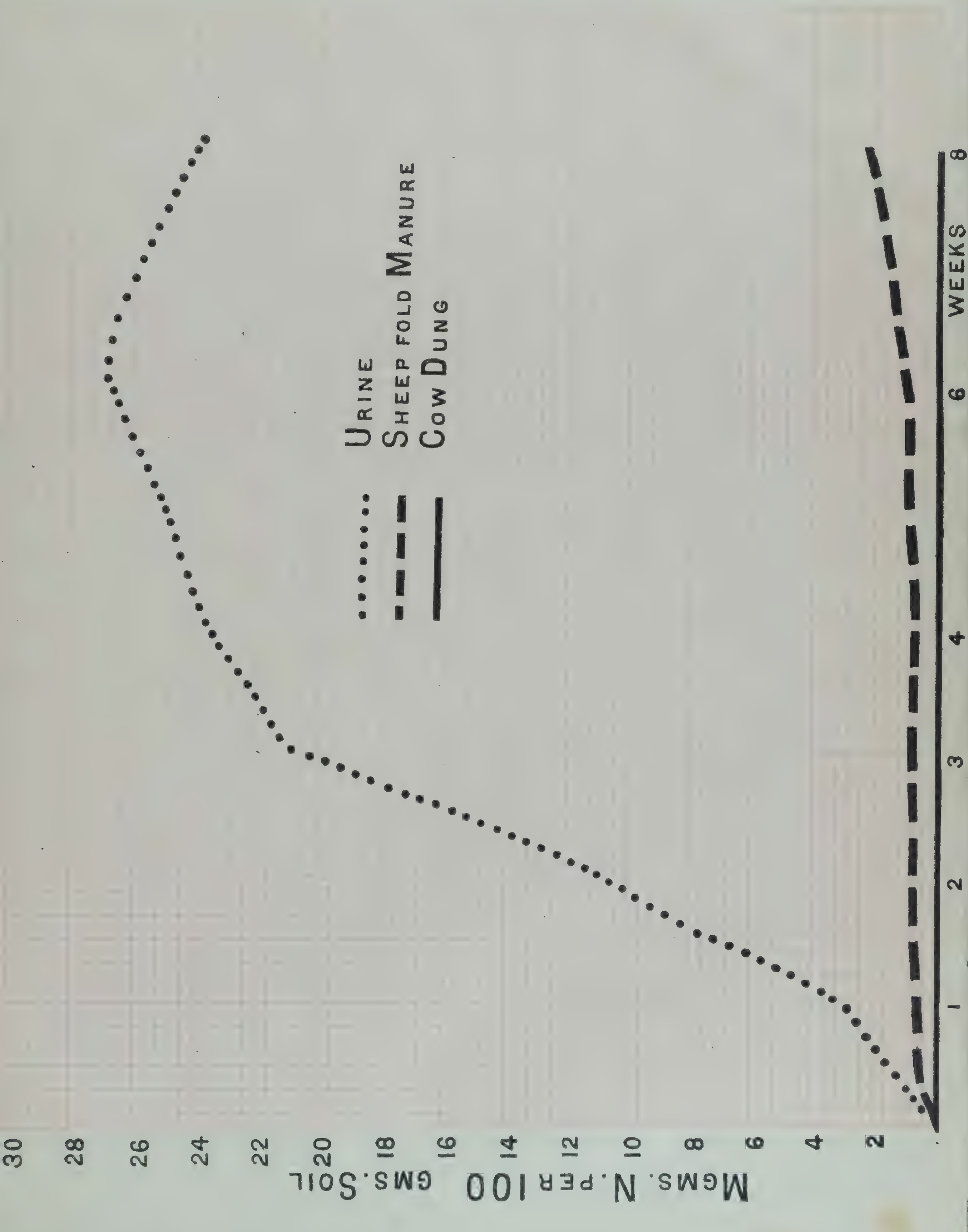
[1] Joshi, N. V. *Agric. Journ. of India.* Special Indian Science Congress No., 1919, p. 400.

CHART I.



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MGMS. N. PER 100 GMS. SOIL
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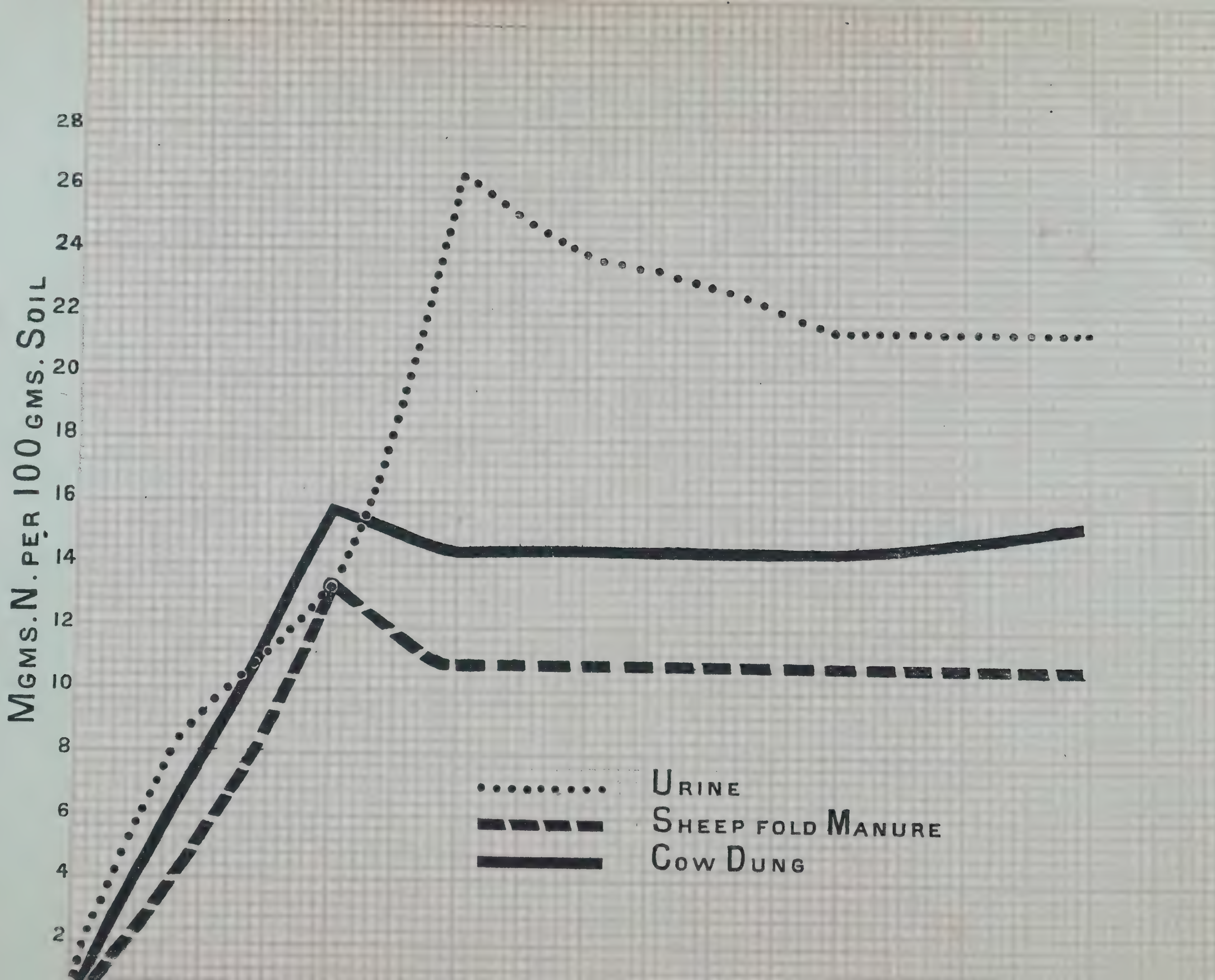
WEEKS
URINE
SHEEP FOLD MANURE
COW DUNG


Mgms. N. per 100 gms. Soil
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Urine
Sheep fold Manure
Cow Dung

CHA

In Chart I, the amounts of nitrates formed by the decomposition of cow-dung, urine and sheep-fold manure, as found by analysis, are plotted in the form of curves. It is clear that cow-dung does not show any nitrate formation. Urine shows the greatest amount of nitrates, while sheep-fold manure, which is a mixture of dung and urine, stands between the two. In the opinion of the present writer these results confirm the previous contention that the absence of nitrate accumulation (as in the case of cow-dung and sheep-fold manure) is due to the nitrate reduction occurring in the presence of great quantities of non-nitrogenous materials such as cellulose, since the nitrates are found to vary inversely as the amount of non-nitrogenous material. Cow-dung, which contains the greatest amount of non-nitrogenous material associated with the nitrogenous one, shows the least amount of nitrates; urine, which has the least amount of non-nitrogenous material associated with the nitrogenous one, has given rise to the greatest amount of nitrate; while sheep-fold manure is intermediate between the two, both as regards its non-nitrogenous content and the amount of nitrates found.

Since farmyard manure consists mainly of dung and urine which have undergone some changes, aerobic as well as anaerobic, in heaps or manure pits, it was proposed to see what effect the storage has on the decomposition of each of these materials singly with special reference to nitrate formation. For this purpose the materials left over after use in the first experiment and kept in open jars with clock glass covers were used. Fresh determinations of nitrogen and moisture content were made and the materials were then separately added to soil on the same basis—30 mgm. N per 100 grm. of soil as before. Chart II gives the results showing that while urine has retained its place as regards high nitrifiability, cow-dung and sheep-fold manure have exchanged places; cow-dung, after storage, is superior to sheep-dung, and further a greater amount of nitrogen has been transformed into nitrates both in the case of the stored cow-dung and sheep-fold manure than the amounts so transformed from these substances in fresh condition.

The results of one experiment were, however, considered insufficient proof, because it was realized that the composition of cow-dung is not uniform in all seasons and might also vary with the food given. Another experiment was therefore arranged on the same lines as before about four months after the first, and this time the addition of straw (which usually finds its way into the manure heap) was introduced as a variation, so that each of the materials used was tried, with and without straw, there being thus six bottles instead of three as in the previous two experiments. The straw added amounted to only 0·5 to 0·6 per cent. of the quantity of dung employed, although the amount of straw heaped together with cow-dung in the manure pit was estimated to be about 20 per cent. of the quantity of dung. This estimate is confirmed by the figures, kindly supplied by Dr. Mann, of one particular experiment lasting for one week made at the Poona Agricultural College Farm.

The figures are as follows :—

Cow-dung	..	..	..	3.886 lb.
Straw	..	..	..	862 lb.

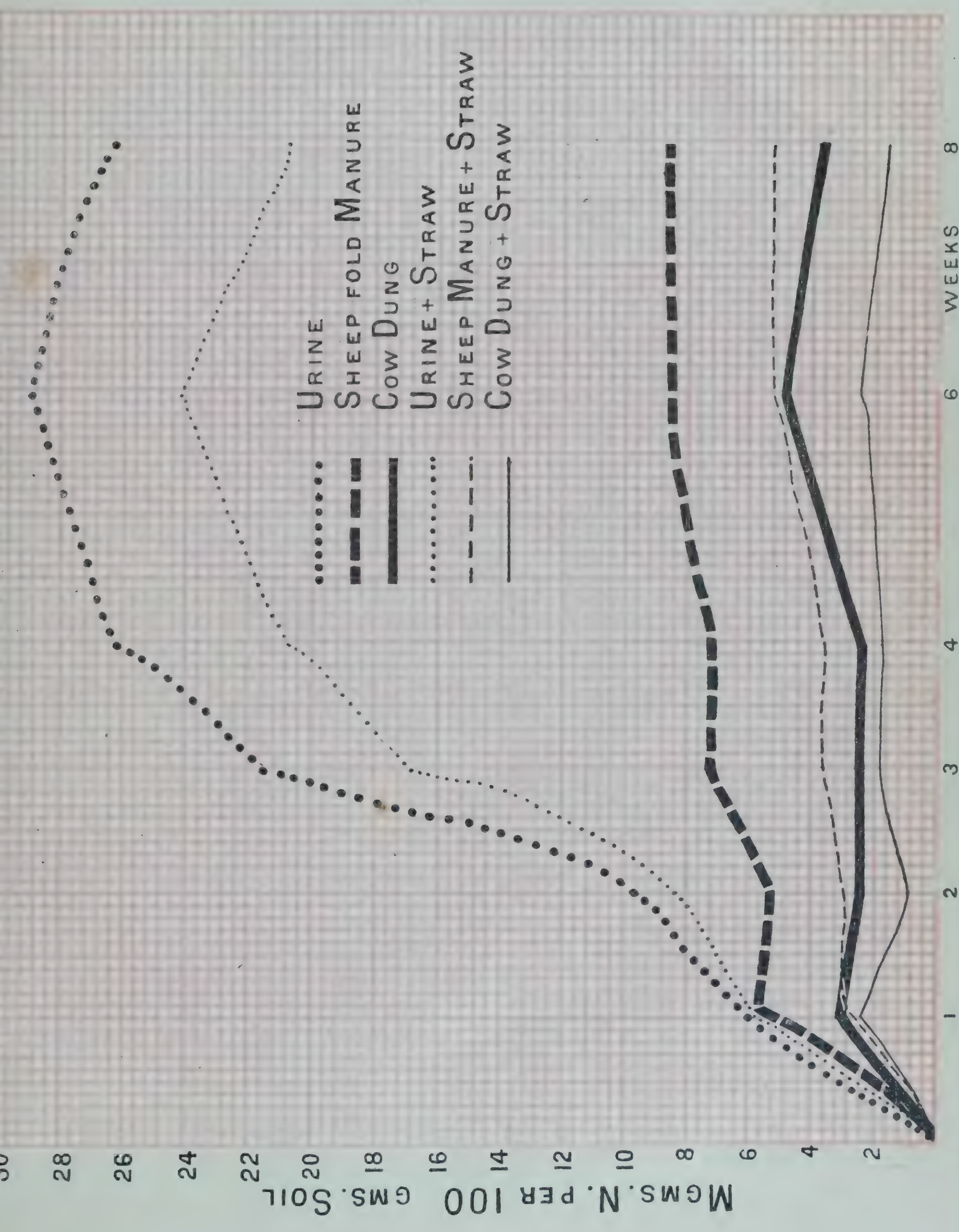
which show that the straw is about 22·2 per cent. of the cow-dung.

The smaller quantity of straw was employed because in some other experiments it had been found sufficient to show its effects on the course of nitrification.

Chart III illustrates the results. It will be seen that they are of the same type as those obtained in the two previous experiments, and further that the addition of straw had the effect of lowering the amount of nitrate found in each case.

In order to see the effect of storage as in the previous case, cow-dung, urine and sheep-fold manure which had remained after use in the third experiment were divided each into two equal lots and each lot was stored in a separate jar. The jars were then divided into two sets. Jars in one set comprising one lot of each of these substances were covered with ground glass plates, which were then made airtight on the edges of the jar by rubber lute with a view to exclude the outside air, thus securing the storage of the materials under anaerobic conditions as far as possible. In the other set the jars had only paper covers and thus had access to

CHART III.



Urine
Sheep fold Manure
Cow Dung
Urine + Straw
Sheep Manure + Straw
Cow Dung + Straw
Mgms. N. per 100 gms. Soil
2
4
6
8
10
12
14
16
18
20
22
24
26
28
1
2
3
4
6
8
Weeks

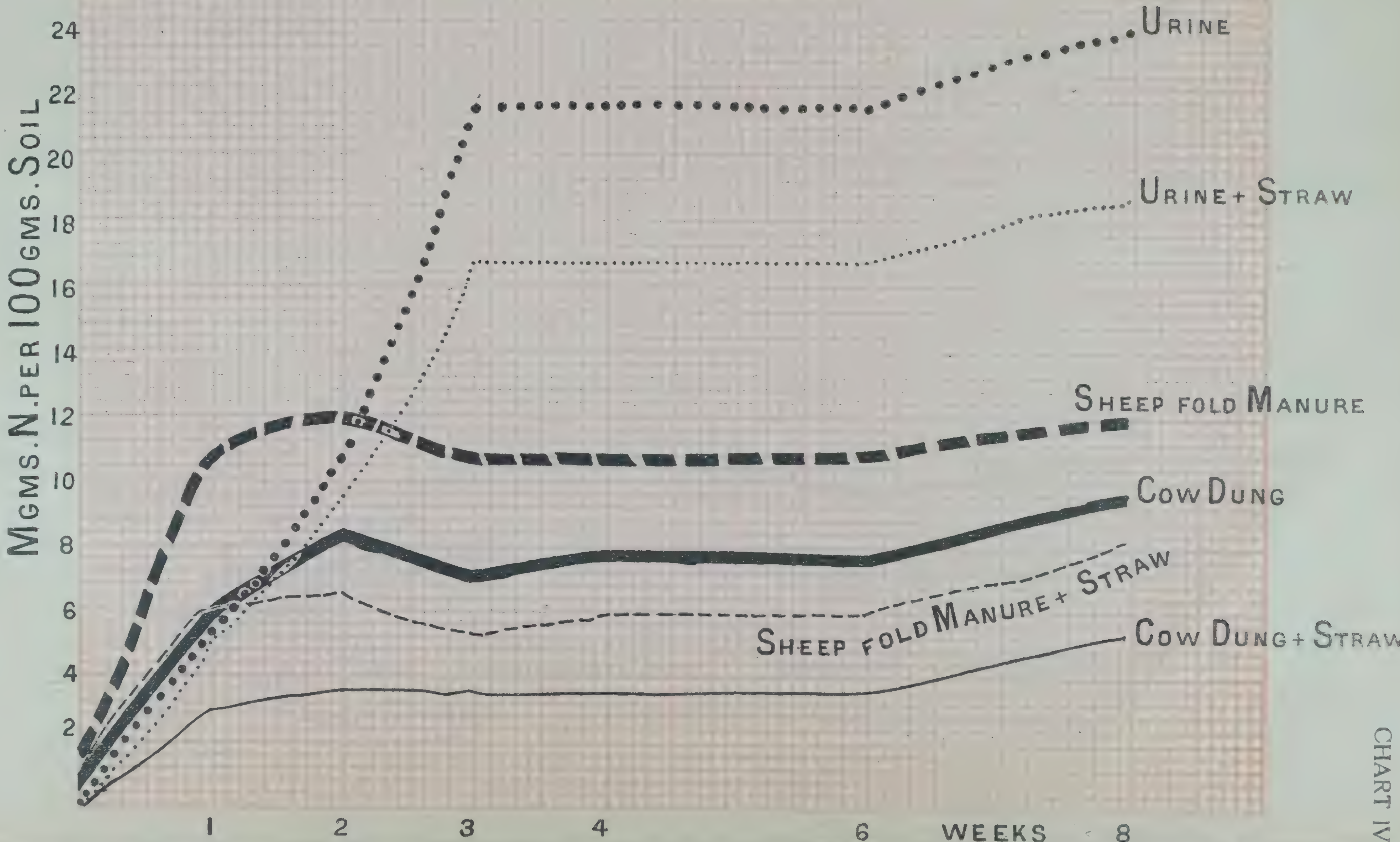
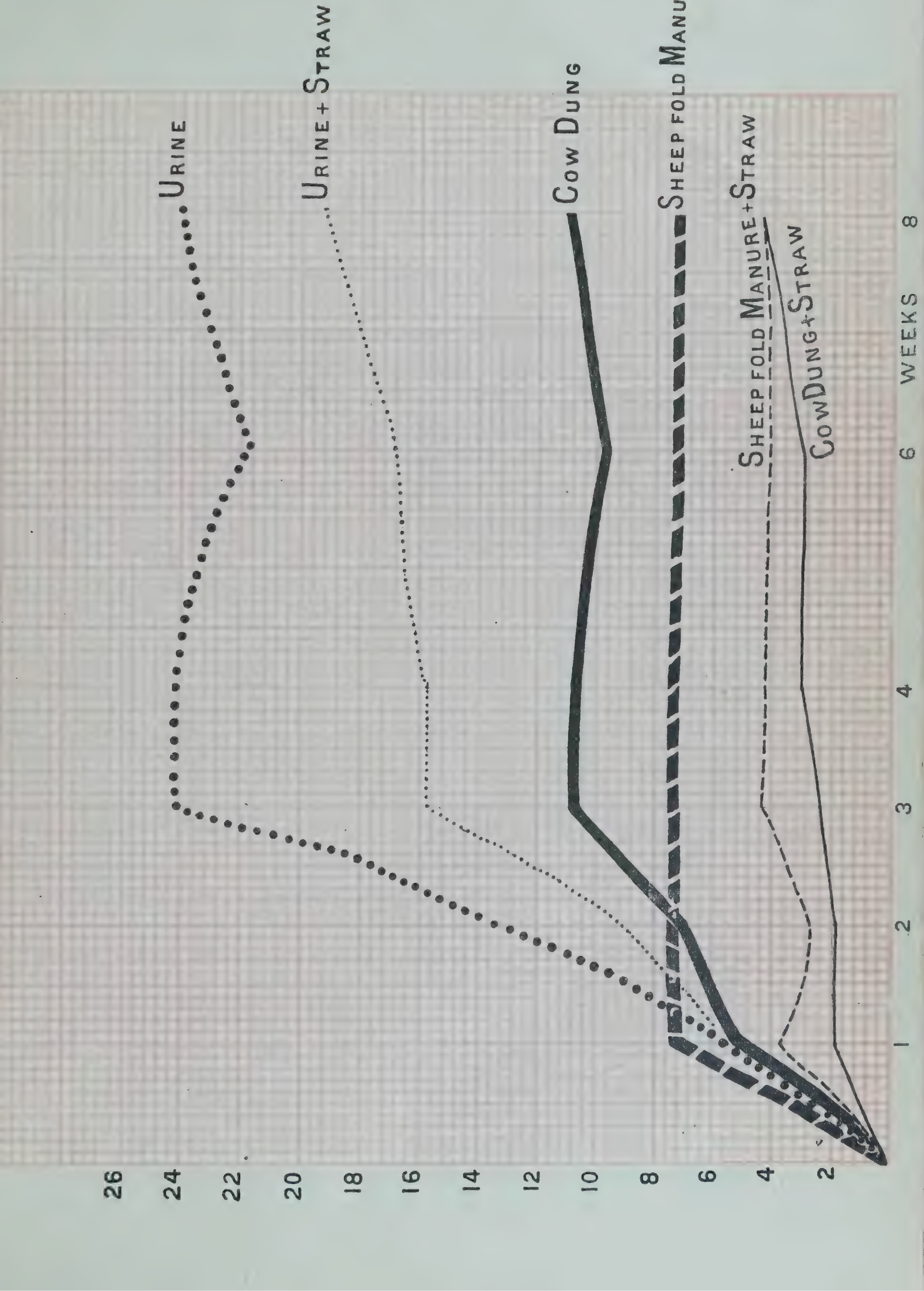

Urine
Urine + Straw
Sheep fold Manure
Cow Dung
Sheep fold Manure + Straw
Cow Dung + Straw
Mgms. N. per 100 gms. Soil
24
22
20
18
16
14
12
10
8
6
4
2
1
2
3
4
6
Weeks
8

CHART IV.

CHART V.



Urine
Urine + Straw
Cow Dung
Sheep fold Manure
Sheep fold Manure + Straw
Cow Dung + Straw
Weeks
1
2
3
4
6
8
2
4
6
8
10
12
14
16
18
20
22
24
26

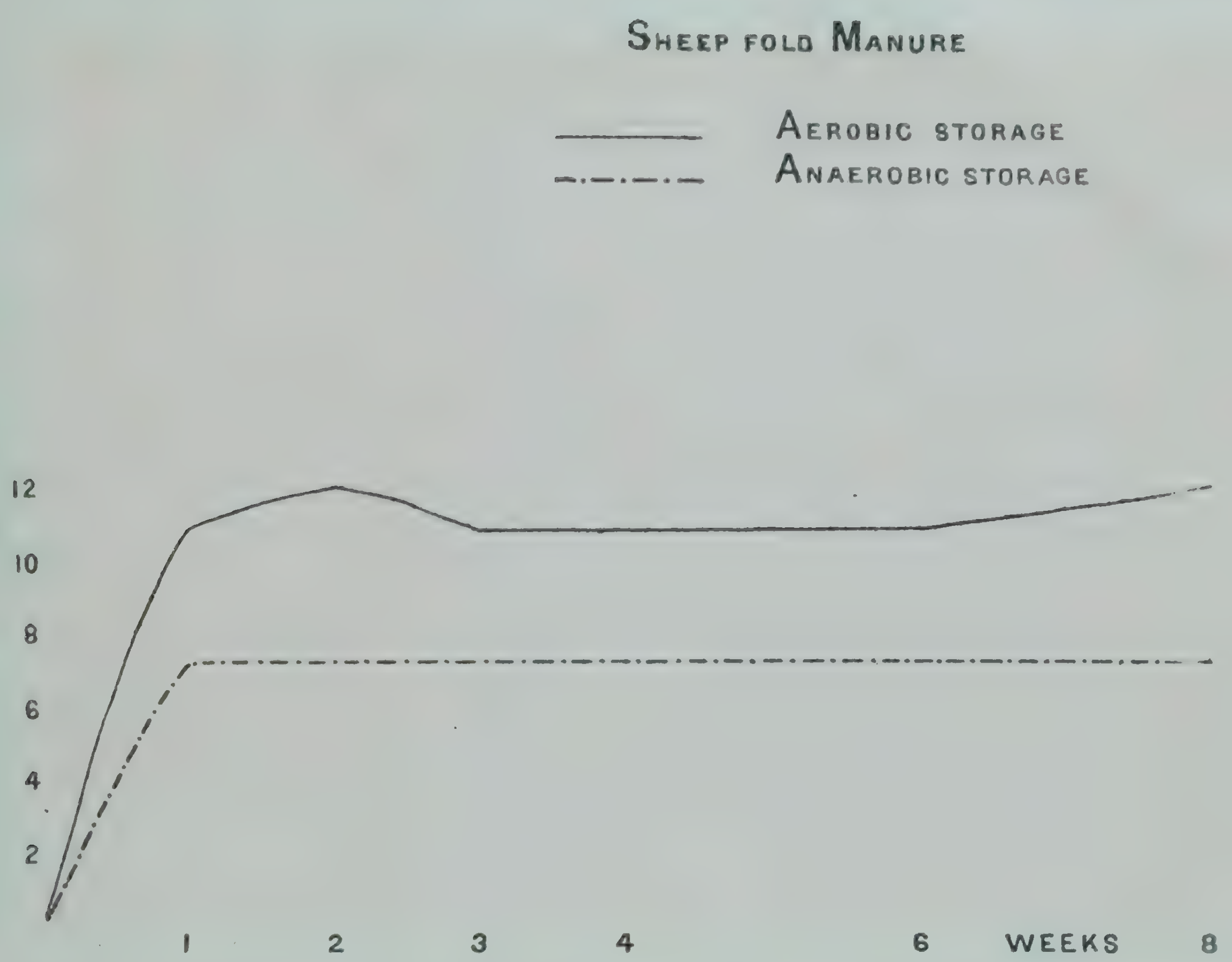
outside air ; this set is therefore called "aerobic." No attempt was, however, made to pass the current of air over the materials in the aerobic set. Both these sets of jars were left at laboratory temperatures varying between 28° C. to 30° C. After a few months' storage under these conditions, the materials as fermented were taken out, their moisture and nitrogen content determined and then they were separately incorporated in the soil. The variation introduced by the addition of straw was retained in both cases. Other conditions of the experiment were also the same as before. The results are shown in two separate charts, Nos. IV and V. The aerobically fermented materials have practically given the same results as in the previous case, except that the sheep-fold manure gives slightly more nitrates than the cow-dung. In the case of the anaerobically fermented ones it will be seen that although urine retains its high place as regards its nitrifiability, the anaerobically fermented sheep-fold manure and the anaerobically fermented cow-dung have changed places. The straw has shown its effect, *viz.*, that of lowering the amounts of nitrates, in every case. Comparing the results of the two sets it may be observed that although there is very little difference between the amounts of nitrate formed from the cow-dung fermented aerobically or anaerobically, still there is a good deal of difference between the two lots of sheep-fold manure. This is illustrated in a separate chart (No. VI) comparing the two, from which it will be seen that the anaerobically fermented sheep-fold manure is inferior to the aerobically fermented one. As such difference is not noticeable in the case of cow-dung or urine when each of them is stored separately, but noticeable only in the case of sheep-fold manure, it is natural to enquire whether this inferiority with reference to nitrifiability of the anaerobically fermented sheep-fold manure is not due to the fact that it is a mixture of dung and urine ; and whether separate storage of dung and urine of cattle would not be more advantageous than the addition of the urine into the manure pit ? The question is well worth further study not only from the point of view of nitrifiability of material but also from another point of view, *viz.*, the loss of nitrogen during storage, as it was incidentally noticed that under anaerobic

conditions of storage there was no loss of nitrogen from urine, that from cow-dung only slight, but sheep-fold manure under anaerobic conditions lost more nitrogen than either.

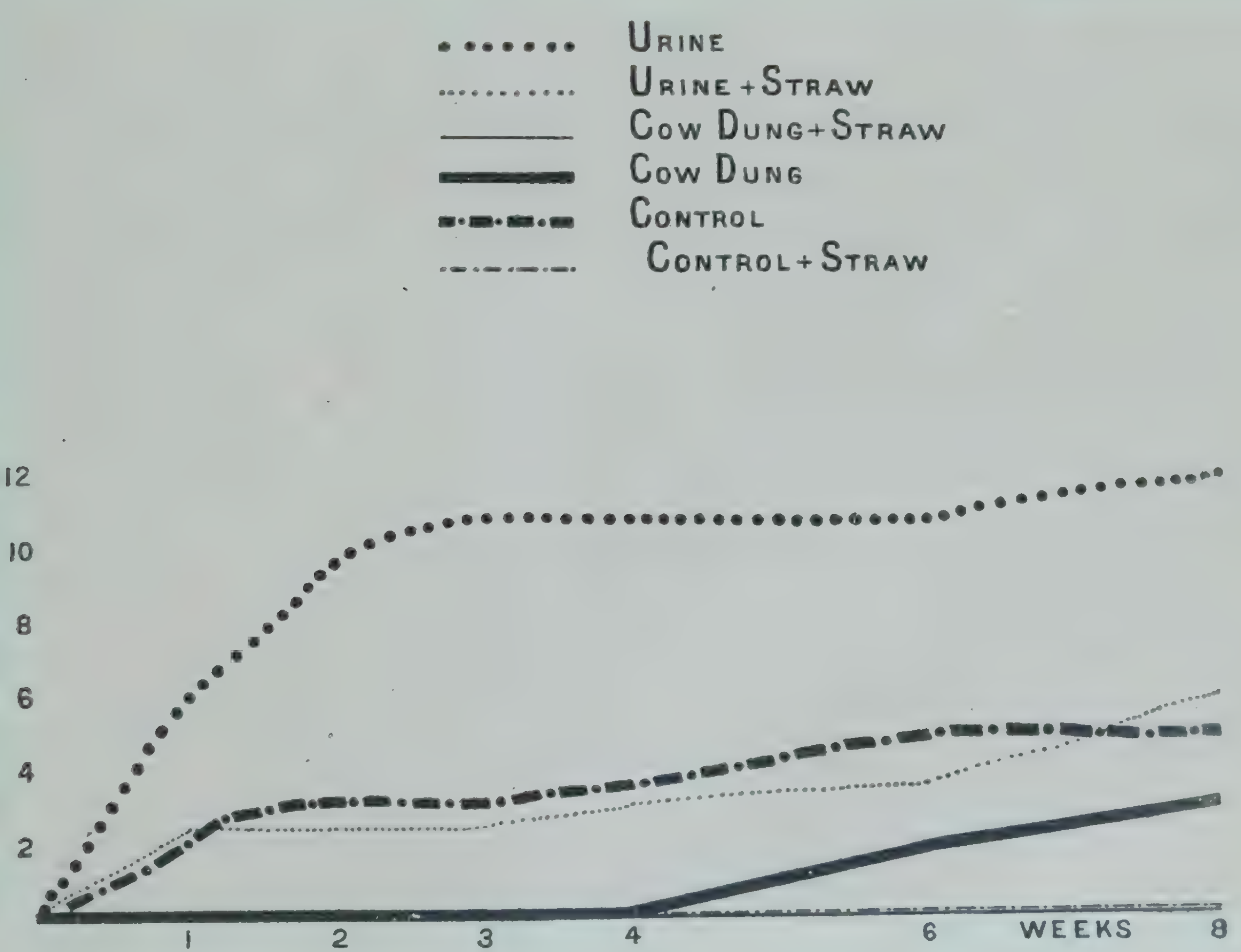
Under aerobic conditions there was loss in all cases, but as the figures for loss in moisture under these conditions were not accurately determined beforehand, no opinion can be expressed as to the relative loss of nitrogen from each of the materials. This question of loss of nitrogen during storage is being further investigated to obtain more accurate information.

It must have occurred to many that the experiments carried out so far are open to one serious criticism, *viz.*, the excessive amounts of materials used in the experiments. These are no doubt higher than the amounts normally employed in the field. But these quantities were taken with due regard to the amount of nitrogen which had previously been found suitable for nitrification experiments with Pusa soil and to the fact that the concentration of nitrogen should be such as to enable one to detect even small differences in what may be termed the nitrifiability of materials. In order, however, to leave no room for criticism of such a kind, and also on account of the very wide differences in nitrifiability of materials compared (as already noticed in these trials), a fresh experiment was arranged in which the quantities employed approximated to what may be called heavy manuring such as is given to garden crops or other soil-exhausting crops like tobacco. The quantity of manure employed was calculated on the basis of 50 cart-loads, *i.e.*, about 25 tons of farmyard manure per acre. For ordinary crops 25 cart-loads are considered sufficient for Pusa soil. These quantities were found to supply 15 mgm. of N per 100 grm. of soil instead of 30 mgm. as before. The addition of straw was retained as a variation. Sheep-fold manure was not available at the time. Soil alone and soil plus straw were introduced as controls.

In addition to nitrification experiments, CO_2 production experiments were carried out. The CO_2 produced in soil by each of these treatments was measured every day in order to see whether there is any relation between the process of nitrification, as represented by

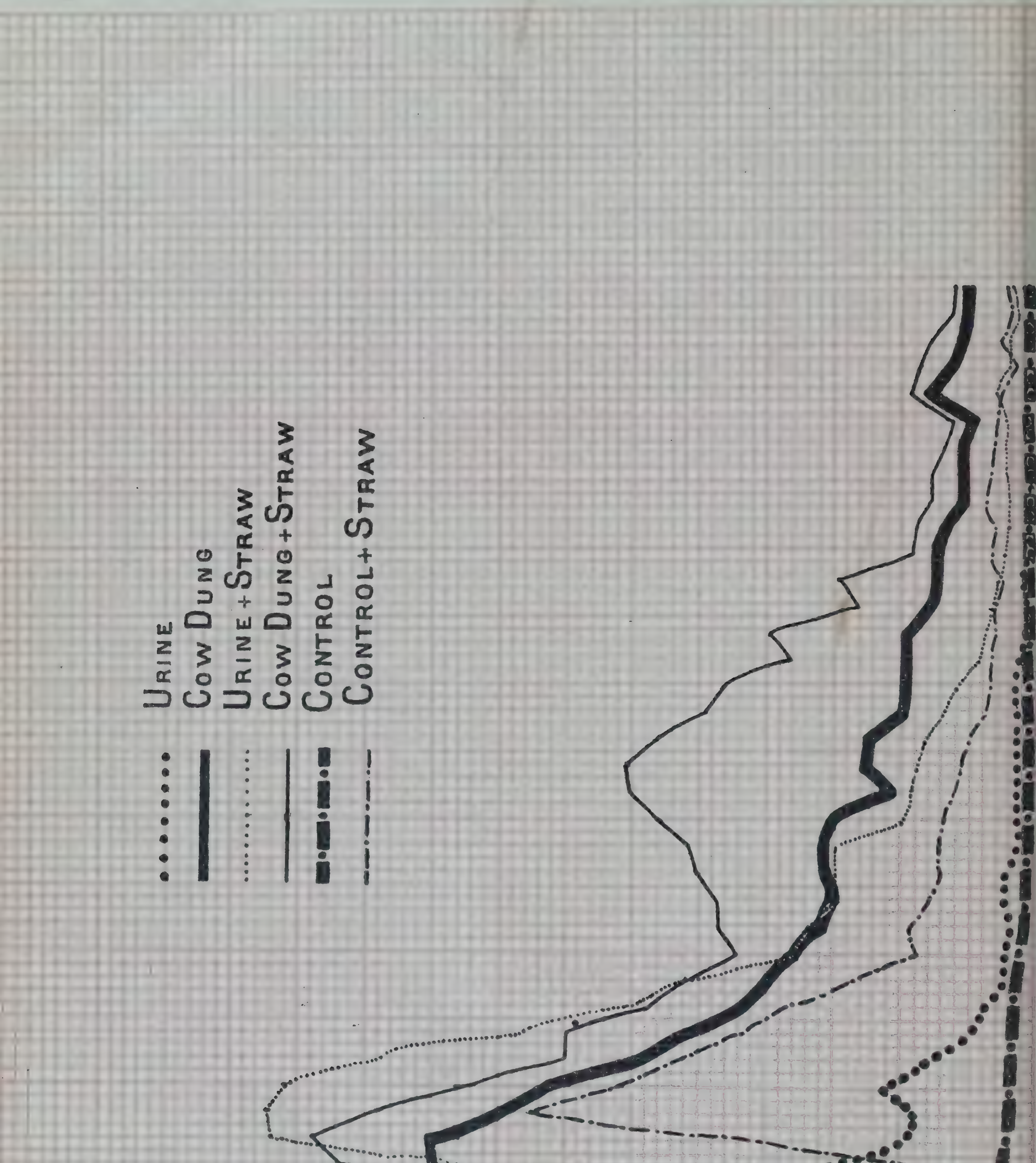


SHEEP FOLD MANURE
AEROBIC STORAGE
ANAEROBIC STORAGE
12
10
8
6
4
2
1
2
3
4
6
WEEKS
8



URINE
URINE + STRAW
COW DUNG + STRAW
COW DUNG
CONTROL
CONTROL + STRAW
12
10
8
6
4
2
1
2
3
4
6
WEEKS
8

CHART VIII.



Urine
Cow Dung
Urine + Straw
Cow Dung + Straw
Control
Control + Straw
Mgms. CO_2 per 100 gms. Soil
60
55
50
45
40
35
30
25
20
15
10
5

the amount of nitrates which are the final product of the nitrogen changes, and the process of CO_2 production, which latter may be said to measure the general biological activity of the soil.

Furthermore, soils receiving the different treatments were plated out and bacterial counts made to see whether the number of bacteria and the amount of CO_2 produced could be correlated.

It was considered advisable to determine also the total nitrogen along with ammonia, nitrites, nitrates, etc. Besides, samples of soil were taken from each nitrification jar for determining the moisture content, loss on ignition and humus every week.

Charts VII, VIII and IX and Table I show the results which may, in general, be set down as follows.

The nitrate curves (Chart VII) fully confirm the results obtained in the previous two cases ; fresh cow-dung shows practically no nitrate formation, while urine shows the highest. The addition of straw, as in the previous experiments, lowers the amount of nitrates.

The CO_2 production (Chart VIII) shows practically an inverse order as regards cow-dung and urine, cow-dung giving a much higher amount than urine. As regards the effect of addition of straw on CO_2 production, it may be observed that increased amounts of CO_2 are produced where straw is added as in the case of the control plus straw and urine plus straw as compared to the corresponding lots without straw. In the case of cow-dung, however, no such marked difference is observable, which may be explained by the fact that cow-dung itself contains a large quantity of undigested cellulose material ; a further small addition in the shape of straw does not therefore affect the results to any great extent. The fact that nitrate curves and CO_2 curves are in the inverse order, and further that the addition of straw while lowering the amounts of nitrates leads to increased production of CO_2 needs to be emphasized. Previous writers have, on account of the similarity of curves for nitrate content and CO_2 production, tried to justify the view that the two processes are related to each other. It will appear as a result of our experiments, however, that these two processes are not necessarily correlated.

Chart IX illustrates the curves for bacterial numbers. A comparison of this chart with the previous one of CO_2 production shows a close similarity between the two sets of curves, which leads to the inference that the CO_2 production is directly related to the bacterial numbers.

Figures for total nitrogen are given in the accompanying table.

TABLE I.

Milligrams of total Nitrogen per 100 *grm. of soil.*

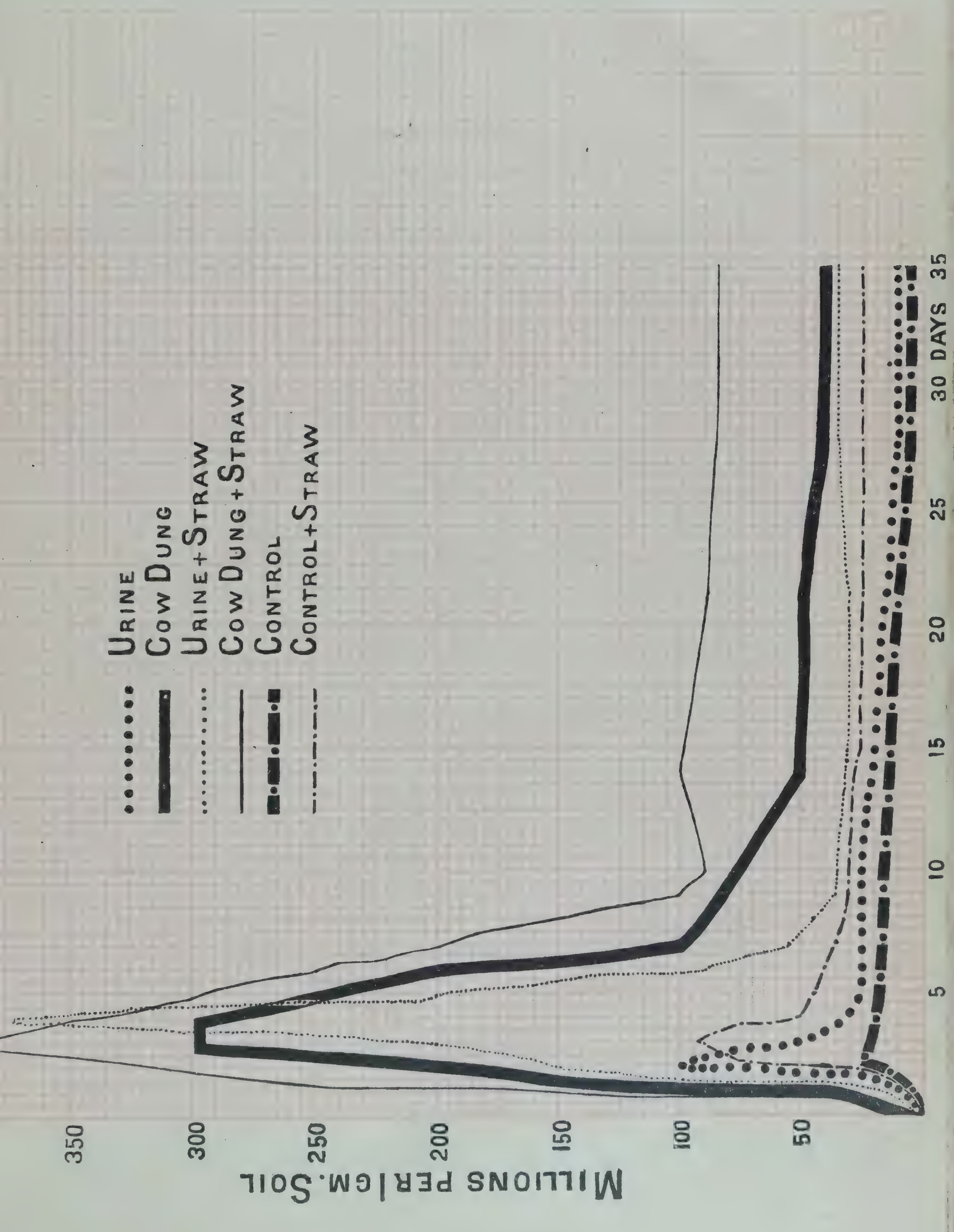
Treatment	Original	1st week	2nd week	4th week	6th week	8th week
Soil control ..	57·4	57·4	57·4	57·4	56·0	56·0
Soil+straw ..	60·2	60·2	60·2	60·2	61·6	61·6
Soil+cow-dung ..	75·2	79·8	79·8	81·2	81·2	81·2
Soil+cow-dung+straw	78·0	82·6	81·2	82·6	88·2	86·8
Soil+urine ..	72·4	70·0	70·0	68·6	72·8	71·4
Soil+urine+straw ..	75·2	79·8	79·8	79·8	82·6	79·8

It is interesting to note that the figures for total nitrogen determined weekly are higher in those cases where there is less nitrification (*e.g.*, in all those cases where straw has been added), and in order to account for this fact, it requires to be investigated whether there is any loss of nitrogen during nitrification or whether there is greater nitrogen fixation with the cellulose materials. A third alternative possibility, which has to be considered, is that the method for estimation of total nitrogen (which is meant and supposed to include nitrates) may be at fault. It is necessary, therefore, to examine critically whether any loss of nitrogen occurs during digestion, when nitrates in unusually greater quantities are present.

It may be mentioned that in the method used for determining the total nitrogen in the soil, copper sulphate was used instead of mercuric oxide, as this was recommended by Scott[1], and also because it was found that the use of the latter consistently gave lower

[1] Scott. *Standard Methods of Chemical Analysis.* Second Ed., p. 295.

CHART IX.



Urine
Cow Dung
Urine + Straw
Cow Dung + Straw
Control
Control + Straw
Millions per I gm. Soil
350
300
250
200
150
100
50
5
10
15
20
25
30
35
Days

figures, whenever both the methods were compared, in the case of Pusa soil. Whether this result is due to impurities in mercuric oxide remains to be seen.

The only other feature of interest in the rest of the analytical results is that about 50 per cent. of the total humus is found to be free, the rest is combined with lime.

By way of anticipating criticism it might be observed that while the biological decomposition of organic matter is generally recognized to be of fundamental importance to soil fertility, it is nevertheless questioned by many whether a study, even under field conditions, of the processes leading to the decomposition of organic matter, and the assimilation of the resulting products by the plant, is of any real value. According to this line of argument, still less importance attaches to analytical figures obtained in the laboratory of nitrate nitrogen and CO_2 produced. In reply to this it must be said at once that laboratory results are not at all intended to be put forward as directly applicable to field conditions. There is an essential difference between laboratory and field observations, but each has got its own value. Whereas the field observations record the combined result of many factors, the effect of each of which it is not possible to distinguish in the field at once, the investigations in the laboratory give the results of each of the factors singly under rigidly controlled conditions, all factors except the one under investigation being kept constant. Attention might be called, for instance, to the observed differences in nitrification of the different tissues of green manures already described in a previous paper[1] and the differences in the decomposition of cow-dung and urine described in this paper. It would have been hardly possible to distinguish accurately between these differences in the field and, even if observed, most likely they would have been mixed up with some other factor like rainfall.

It may be further mentioned that the value of these laboratory observations on differences in nitrification, described in this paper, lies also in enabling us to distinguish between the separate effects

[1] Joshi, N. V. *Agri. Jourl. of India.* Special Indian Science Congress No., 1919, pp. 395–413.

of the two factors which are involved in manuring with organic nitrogenous fertilizers, *viz.*, the formation of nitrates, and the improvement in physical texture, each of which must affect to a certain extent the crop-producing power of the soil.

In order to discover how far the analytical results of nitrification tests are related to the crop-producing power, pot experiments with leguminous and non-leguminous crops are being carried out with dung and with urine added to the soil in the same proportion as that employed in the last experiments. These experiments are intended to elucidate how far crop production is influenced by variation in nitrification, and also to see what effect physical improvement alone, without any nitrates, has on the crop-producing power of a soil.

The results of the experiments detailed in this paper may now be summarized as follows :—

The opinion expressed in a previous paper that non-nitrogenous materials, like cellulose, lower the amounts of nitrates formed from the organic manures in which they are present in a fairly large proportion is confirmed by experiments with cow-dung, sheep-fold manure and urine.

Urine gives the greatest amount of nitrates, whether in fresh condition or when fermented under aerobic or anaerobic conditions, and so it can be used immediately or after keeping. Urine, if kept exposed to air, loses some of its nitrogen. It is therefore advisable to store it in such a way as not to be accessible to air.

Cow-dung does not nitrify in fresh condition. It, however, improves by storage and becomes nitrifiable after storage under both aerobic and anaerobic conditions. The relative losses under each of these conditions require to be more accurately determined before finally deciding which of these conditions is better so far as nitrifiability is concerned.

Results with sheep-dung indicate that mixture of dung and urine in the manure pit is not desirable from the point of view of nitrate formation, and also on account of the possibility of greater losses of nitrogen from such a mixture under partly anaerobic

conditions which are likely to prevail in the pit or even in a compact heap.

The two processes of nitrification and of CO_2 production, though sometimes found to correspond with each other, do not seem to be necessarily correlated. Nothing definite can be said as yet as to the relation of crop production to nitrification. It is hoped that the experiments now in progress will clear up this point.

COMPARISON OF SALT LANDS IN THE DECCAN AND IN SIND.*

BY

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Of the Bombay Agricultural Department.

Origin of salt lands in Sind and in the Deccan.

The origin of salt lands in Northern India, such as that in the alluvial tract of Sind, and in the South Deccan, which is a trap area, is widely different. In the one, the soils, which are transported, show in vertical sections that the layers of alluvial deposit often vary greatly. It is not unusual to find in such sections layers of pure sand alternating with those of pure clay. The layers themselves usually differ very much in their thickness. All this indicates that the nature of soils in such alluvial tracts can scarcely be uniform, with the result that the development of salts is also very irregular and even a small piece of land measuring a few *gunthas* (40 *gunthas* = one acre) is often seen studded with patches of alkali salts whereas the rest of the field has normally good land. In places like those of Sind where the rainfall is almost negligible and where the sub-soil water table is much more than ten feet below ground level, the development of salt is neither due to water-logging, nor due to the sub-soil water table being within the range of capillary power of the soils, which is generally found not to exert a pull of more than four feet on the sub-soil water.

Inundation flood, which is the chief source of irrigation at present in the northern parts of Sind, supplies water for cultivation

* Paper read at the Seventh Indian Science Congress, Nagpur, 1920.

during the months of June to September. After that severe extremes of weather follow. Excessive cold in winter and scorching heat in the hot season help a great deal in the disintegration of soil particles through which water moves in the downward direction during inundation season and in upward direction for the remaining eight months of the year. It is this downward and upward movement of water in the upper few feet of the soils which is responsible for the formation and deposition of salts in the alluvial tract of Sind.

In the Deccan the soils are mostly formed *in situ* by the disintegration of trap rock, and in vertical sections of soils all the stages of disintegration of the rock can be seen : such as the soil, *murum* or half disintegrated trap rock forming the sub-soil, and below it hard rock unaffected by the natural agencies of weathering. It is on this account that the soils in the Deccan are not so variable in their nature as the soils in Sind and the patchy nature of salt-affected land is not so common (though not altogether absent) as it is in the north of Sind.

The origin of salt lands in the Deccan is to be found in the general rise of sub-soil water table which has risen so high after the introduction of perennial canals as to be within five feet from the surface of the land and oftentimes even less than this. In such cases the sub-soil water constantly rises to the surface by capillarity, and evaporating there, leaves the dissolved salts behind. The lands in the Deccan are, moreover, not so level as those in Sind, so that the soils on lower level are more affected by seepage and water-logging than those on higher level.

Nature of alkali salts in the Deccan and in Sind.

In the Deccan alkali salts are mostly formed by the disintegration and decomposition of trap rock, which is known to be one of the hardest of the common rocks. It is, however, found to yield comparatively easily to the natural agencies of weathering, being at one time covered under the water of the flowing river or canal, etc., and at other time being exposed to the heat of the sun. Probably the soluble salts in the river and canal water also help the

process of weathering. The trap rock being thus the origin of salts, it is interesting to know the nature of salts found to form from it during the process of decomposition.

The following table shows the nature of the river and canal water which always comes in direct contact with the trap rock :—

	Karha river water at Jejuri. Parts per 100,000	Nira Canal water at Pimpra. Parts per 100,000
Calcium carbonate	6·00	8·00
Magnesium carbonate	8·00	....
Sodium carbonate	5·00	1·00
Sodium bi-carbonate	4·00	....
Calcium sulphate	....	5·00
Magnesium sulphate	....	4·00
Sodium sulphate	4·00	....
Sodium and potassium chloride	13·00	6·00
	40·00	24·00

The trap rock, which under the influence of such water disintegrates and decomposes, was found to liberate the following salts in the proportion given below :—

	Slightly disintegrated trap rock	Much disintegrated trap rock
	%	%
Total soluble salts	1·13	1·15
Composition of salts :—		
Calcium carbonate	18·50	2·60
Magnesium carbonate	....	1·30
Calcium sulphate	16·20	..
Magnesium sulphate	12·30	1·30
Sodium sulphate	28·50	12·50
Sodium chloride	23·90	82·50

This shows that sodium sulphate and sodium chloride predominate over all the other salts when trap rock is undergoing decomposition.

It is interesting to compare with these analyses the figures of analyses of salts found in the scrapings from barren salt land near Baramati in the Nira Valley :–

	Scraping I	Scraping II
	%	%
Total salts in dry soil	9·70	37·60
Composition of salts :—		
Calcium carbonate	5·40	0·20
Calcium sulphate	3·40	0·40
Magnesium sulphate	2·30	0·30
Sodium sulphate	48·70	98·00
Sodium chloride	40·00	1·20

These figures also show the preponderance of sodium sulphate and sodium chloride in the composition of alkali salts found in barren salt lands of the valley.

The following are some of the typical analyses of soluble salts from particular spots which show the gradation from fertile to barren land commonly found near Malad in Baramati :—

	Fertile spot		Spot with poor crop		Barren land	
	Surface–3″	3″–9″	Surface–3″	3″–9″	Surface–3″	3″–9″
	%	%	%	%	%	%
Total salts in dry soil	0·39	0·22	0·58	0·86	3·86	1·06
Composition of salts :—						
Calcium carbonate ..	3·90	12·90	2·40	2·90	6·20	2·40
Magnesium carbonate	..	5·90	..	..	..	..
Sodium carbonate ..	4·40	8·60	1·60	7·00	2·60	1·10
Calcium sulphate ..	20·00	..	37·30	8·20	28·00	12·50
Magnesium sulphate.	9·10	4·20	26·50	..	..	8·90
Sodium sulphate ..	..	49·50	..	22·60	..	8·50
Calcium chloride ..	..	..	..	..	16·20	..
Magnesium chloride	..	..	7·80	..	13·40	..
Sodium chloride ..	62·20	19·90	24·20	59·40	41·90	66·50

In the majority of the alluvial tracts of Sind, the alkali salts are not naturally derived from any particular rock as the alluvium deposited there is of a varied character, being a mixture of

disintegrated particles of various rocks existing on the top of the Himalayas and down in the flats of the Punjab. There is therefore no particular rock whose decomposition products can be compared with those of the trap rock of the Deccan, the alkali salts in Sind being decomposition products of the alluvium itself.

The waters of the Indus and its canals which come in direct contact with the alluvial deposits gave the following analyses when the waters were collected during dry season :—

	Indus water near Sukkur	Water from the Hiral Canal
	Parts per 100,000.	
Total soluble salts	30·00	22·00
CONTAINING :—		
Calcium carbonate	5·01	6·24
Magnesium carbonate	....	....
Calcium sulphate	12·72	1·56
Magnesium sulphate	....	6·83
Calcium chloride	1·93	....
Magnesium chloride	6·86	3·25
Sodium chloride	1·16	1·78

The following are some of the typical analyses of alluvial deposits which are not yet injured by the accumulation of harmful salts :—

	Good land under cotton. Soil surface–6″	Good garden land. Soil surface–6″	Good land under wheat. Soil surface–6″
	%	%	%
Total soluble salts ..	0·13	0·21	0·30
CONTAINING :—			
Calcium carbonate ..	0·05	0·05	0·07
Sodium carbonate ..	..	0·02	0·02
Calcium sulphate ..	..	0·01	0·02
Magnesium sulphate ..	0·01	..	0·03
Calcium chloride ..	..	0·02	..
Magnesium chloride ..	0·05	0·04	0·01
Sodium chloride ..	..	..	0·06

Scrapings from barren lands of different types which could be clearly distinguished by the presence of white and black 'kalar'* gave the following composition :—

	I. White *kalar* at Sarhari	II. Black *kalar* at Sukkur	III. Black *kalar* at Nawabshah
	%	%	%
Total salts in dry soil ..	24·60	20·24	7·80
COMPOSITION OF SALTS :—			
Calcium carbonate ..	0·13	0·19	0·39
Sodium carbonate ..	0·05	..	0·13
Calcium sulphate ..	5·73	14·15	9·78
Magnesium sulphate ..	1·13	..	..
Sodium sulphate ..	9·12	..	..
Calcium chloride ..	..	10·66	22·46
Magnesium chloride ..	..	14·21	21·14
Sodium chloride ..	83·84	60·79	46·10

It is clear from these figures that chlorides form more than 80 per cent. of the total salts of which sodium chloride is more than 45 per cent. Sulphates are present from 9 to 14 per cent. of the total salts, and in the white *kalar* sodium sulphate is present to the extent of 9 per cent. of the whole quantity of the salts. Sodium carbonate forms only a negligible quantity of the total salts which shows that the *kalar* of Sind is not of a very bad type.

A very remarkable thing that comes out of these analyses is the fact that sodium carbonate is not a necessary constituent of black *kalar*. It is usually supposed that sodium carbonate has a caustic action on the organic matter of the soil which gives a black appearance to the surface soil and hence the name black *kalar* to sodium carbonate, so that black *kalar* means sodium carbonate. From the above figures, however, it will be seen that No. II does not contain any sodium carbonate at all and No. III contains only a very small quantity, and yet the appearance of the surface soil at both these places is sufficiently dark to distinguish the spots as affected by black *kalar*. The only salts in No. II and No. III

* *Kalar, Lona, Usar, Reh* are synonymous terms used in different parts of India to mean salt efflorescence on the land.

to which the dark appearance of the soil may be due are calcium chloride and magnesium chloride. Of these, the former is known to have corrosive action on organic matter.[1] The black *kalar* on Sind soils, therefore, does not contain any appreciable quantity of sodium carbonate but contains a fairly large quantity of calcium chloride and magnesium chloride which are not injurious to plants like sodium carbonate or sodium sulphate.

On comparing the different types of *kalar* in Sind with those of *lona* in the Deccan it will be at once clear that the salt efflorescence in the Deccan contains comparatively a very large proportion of sodium sulphate, whereas in Sind sodium chloride predominates over all the other salts.

Resistance of crops towards salts.

In the Deccan the ordinary black soil does not usually contain more than 0·1 per cent. of soluble salts, but this does not necessarily mark the limit of salts up to which crops can be grown. Several crops have been found to resist the effect of salts much beyond this quantity, and the following are some of the analyses which indicate the limit of tolerance shown by some of the ordinary crops.

	Sugarcane. Soil surface–5″	*Chowli* (Vigna catjang). Soil surface–4″	*Wal* (Dolichos lablab). Soil surface–4″	Gram (Cicer arietinum). Soil surface–4″
	%	%	%	%
Total salts in dry soil ..	0·96	0·45	0·42	0·42
Composition of salts:—				
Calcium carbonate ..	6·80	12·62	4·76	5·24
Sodium carbonate ..	..	0·97	5·00	1·19
Calcium sulphate ..	43·00	33·00	3·33	30·70
Magnesium sulphate ..	1·00	28·65	9·53	15·24
Sodium sulphate ..	25·90	8·74	57·86	20·49
Sodium chloride ..	23·30	16·02	19·52	27·14

Of these crops sugarcane was growing excellently, being also supplied with heavy manuring. *Chowli* and *Wal* were doing fairly well and gram germinated well but failed later on.

[1] *U. S. A. Bureau of Soils Bulletin* No. 34.

Lakh (*Lathyrus sativus*) and Udid (*Phaseolus radiatus*) were similarly found to fail in a soil containing 0·48 per cent. of soluble salts of which sodium sulphate was about 66 per cent.

The following are a few of the analyses of Sind soils showing approximate limit of tolerance of some crops towards salts contained in the soil :—

	Rice. Soil surface–6″	*Lakh* (Lathyrus sativus). Soil surface–6″	Cotton. Soil surface–6″	Wheat. Soil surface–6″
	%	%	%	%
Total salts in dry soil ...	1·86	0·61	2·10	3·00
COMPOSITION OF SALTS :—				
Calcium carbonate ..	3·16	18·64	3·85	1·14
Calcium sulphate ..	8·87	16·94	51·92	22·05
Magnesium sulphate ..	14·55	27·51	10·26	..
Sodium sulphate ..	18·96	..	14·74	..
Calcium chloride ..	..	..	..	18·25
Magnesium chloride ..	..	20·34	..	16·35
Sodium chloride ..	54·43	16·94	19·23	42·21

The resistance of rice crop towards sodium chloride is well known from the fact that several rice varieties are grown on creek water in Konkan near Bombay.

In Sind, on Larkhana farm, saline water which could just maintain rice crop was found to contain the following amounts of salts :—

	Water confined in rice crop. Parts per 100,000
Total soluble salts	940·00
CONTAINING:—	
Calcium carbonate	5·17
Calcium sulphate	63·68
Magnesium sulphate	43·56
Sodium sulphate	38·34
Sodium chloride	742·50

The above is only an attempt to show approximately the limit of tolerance of several crops towards salt efflorescence in soils. Other factors such as frequent irrigation and consequent dilution during different stages of growth of the crops would materially modify the results.

HABIT IN SUGARCANES.*

BY

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Habit of plant an important character in all cultivated crops.

Habit of plant is a character of considerable importance in all cultivated crops. That each individual plant should be able to make full use of the air and light available to it without interfering with the growth of the neighbouring plants is a condition imposed by agriculture and the closer approximation of the individual plants which agriculture implies. Again, the habit of plant has often a direct bearing on the position of the produce at time of harvest. A cotton plant in which the lateral branches spread on the ground and bring the *kapas* in contact with the soil, dirtying it and thus depreciating its market value, and a paddy plant, which, by its spreading nature, allows its ripe earheads to trail on the ground, are obviously unsuitable for cultivation.

Particular importance of habit in sugarcane.

Habit is of special importance in the case of the cultivated sugarcanes. It is a long duration crop—occupies the land for 9 to 14 months in India, and even as much as 24 months in other countries like Hawaii—and if the neighbouring plants should show a tendency to get entangled with each other, the inter and after cultivation of the crop such as weeding, earthing and irrigation are rendered difficult. Secondly, it is accepted on all hands that

* Paper read at the Seventh Indian Science Congress, Nagpur, 1920.

a lodged cane rapidly degenerates in sucrose content. Dr. Leather, in *Agricultural Ledger*, 1896, says, "The juice of fallen canes was again separately examined, with the result that it was found to contain generally less proportion of cane sugar and a larger one of glucose than was found in the standing cane." Thirdly, a bad habit in the cane leads to the formation at the time of harvest of crooked and curved canes, which is a serious disadvantage from the factory point of view, as it seriously interferes with the compact packing of canes on the hopper. In sugarcane, the ideal would, therefore, be to aim at getting a variety which will consist of a series of parallel erect canes.

Habit of the main shoot during the early stages of growth.

During the early years of the Sugarcane Breeding Station, the depressed habit of the Madras seedling, M. 2, was studied by Dr. C. A. Barber, C.I.E., and Rao Sahib T. S. Venkatraman, and the results were presented in the form of a paper at the Madras Session of this Congress in the year 1915. It was there proved that the depressed habit in the particular Madras seedling was an inherent character resulting from geotropism. This year the study was extended to 20 varieties, chiefly the indigenous Indian canes belonging to the various groups classified by Dr. Barber in his Memoir, "Studies in Indian Sugarcanes, No. 3." Four buds were put down for each variety, but owing to casualties and other abnormalities in growth caused by shoot borers, etc., only 37 plants could be studied to the end of 87 days from planting, and the results are here given.

Statement showing the actual plants studied.

Group	Variety	No. of buds planted	No. of plants examined
Thick canes ..	J. 247	4	4
Nargori ..	Nargori	4	1
	Manga	4	3
	Katari	4	2
	Kewali	4	—
	Carried over	20	10

Group	Variety	No. of buds planted	No. of plants examined
	Brought forward ..	20	10
MUNGO ..	Kuswar	4	2
	Ramgol	4	—
	Matanwar	4	1
	Pararia	4	—
PANSAHI ..	Sanachi	4	4
	Kahu	4	2
	Lata	4	2
	Maneria	4	—
	Pansahi	4	—
SARETHA ..	Katha	4	3
	Lalri	4	1
	Kansar	4	3
	Dhaur Saretha	4	2
	Khari	4	3
	Hullu Kabbu	4	4
	TOTAL ..	80	37

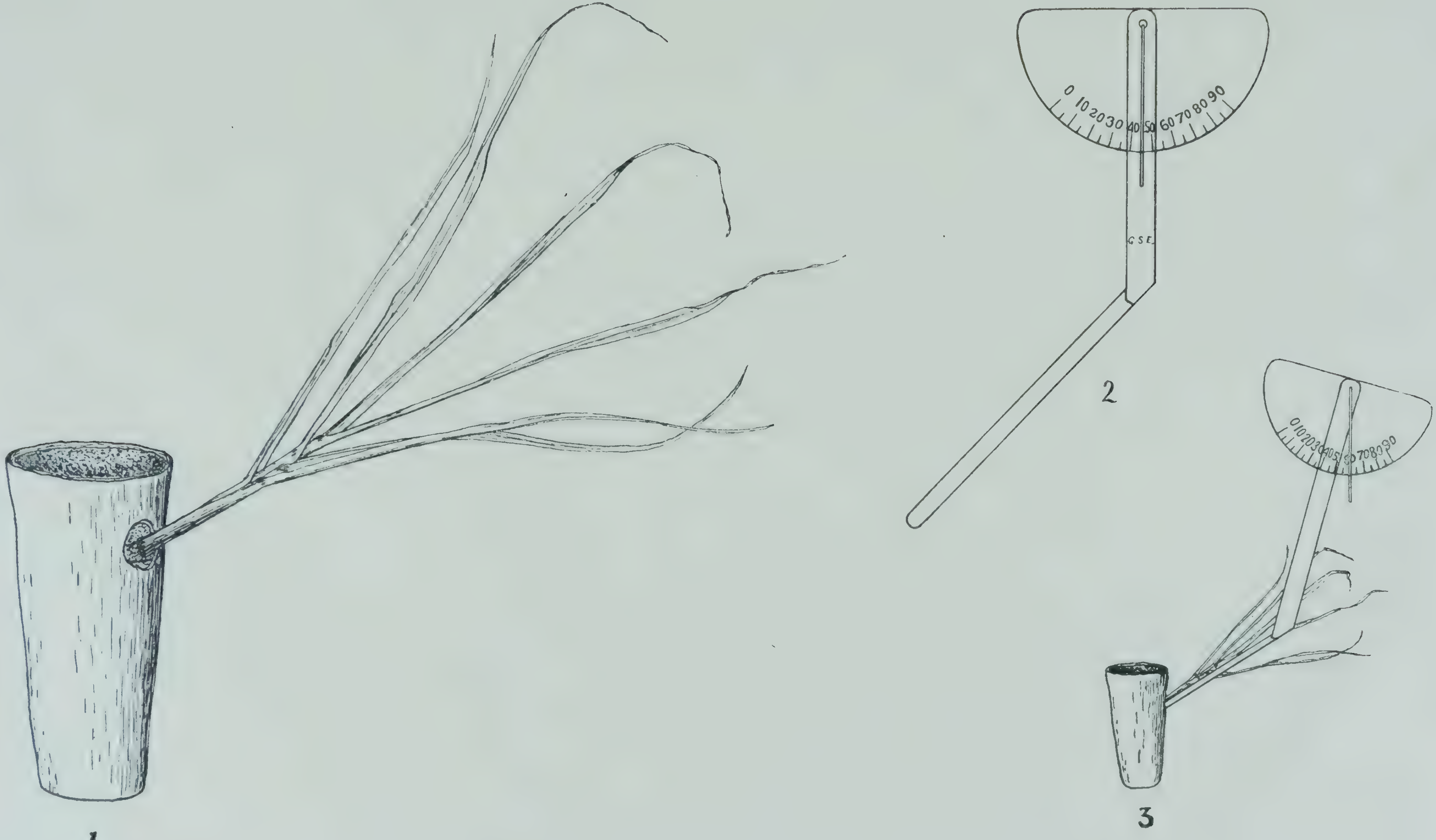
NOTE.—Sunnabile group was left out because of great variation in its components.

The main details of this paper are found in the Memoir " Studies in Indian Sugarcanes, No. 2," page 138.

The buds were planted in tile pots with a lateral hole as seen in Plate XXII, fig. 1, and the angle of the main shoot was measured by means of an instrument (Plate XXII, figs. 2 and 3), being a copy of the one in use at the Paddy Breeding Station under the control of the Government Economic Botanist, Mr. F. R. Parnell. The observations were commenced on the 15th day from planting and continued to the 87th day, when it had to be discontinued, as it was felt that the tile pots were too small to keep the plants any further in a healthy condition. A more extended series, with the plants growing in big sized pots, is being laid to enable a continuation of this study up to the harvest of the canes. Each day two observations were recorded, one in the morning at 8 a.m., and another in the evening at 3 p.m., but as little difference was noticed between the two observations on the same day, only the morning observations were taken for study.

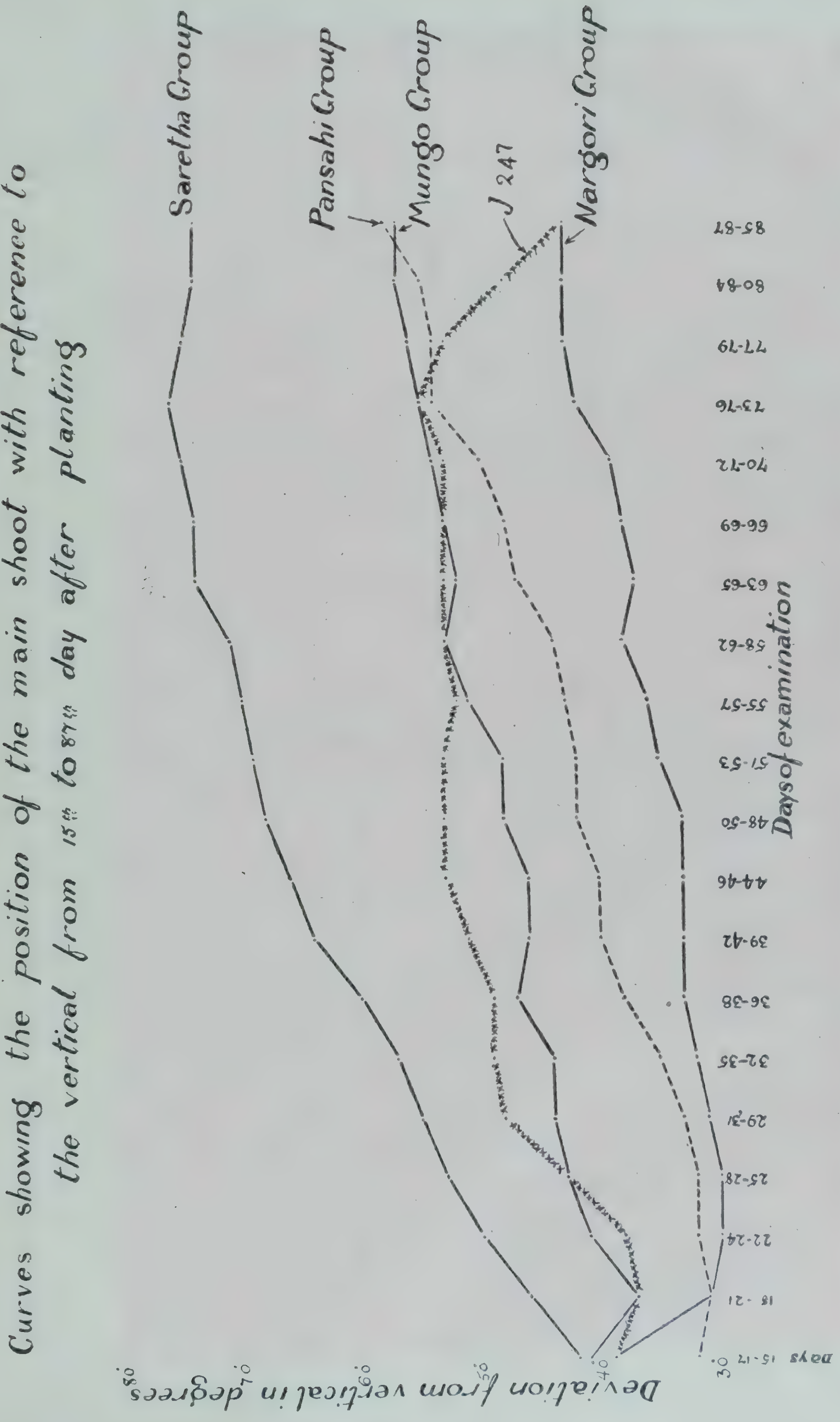
The curves in Chart I were plotted from the bi-weekly averages of the daily angles of the varieties in that group. Note the great

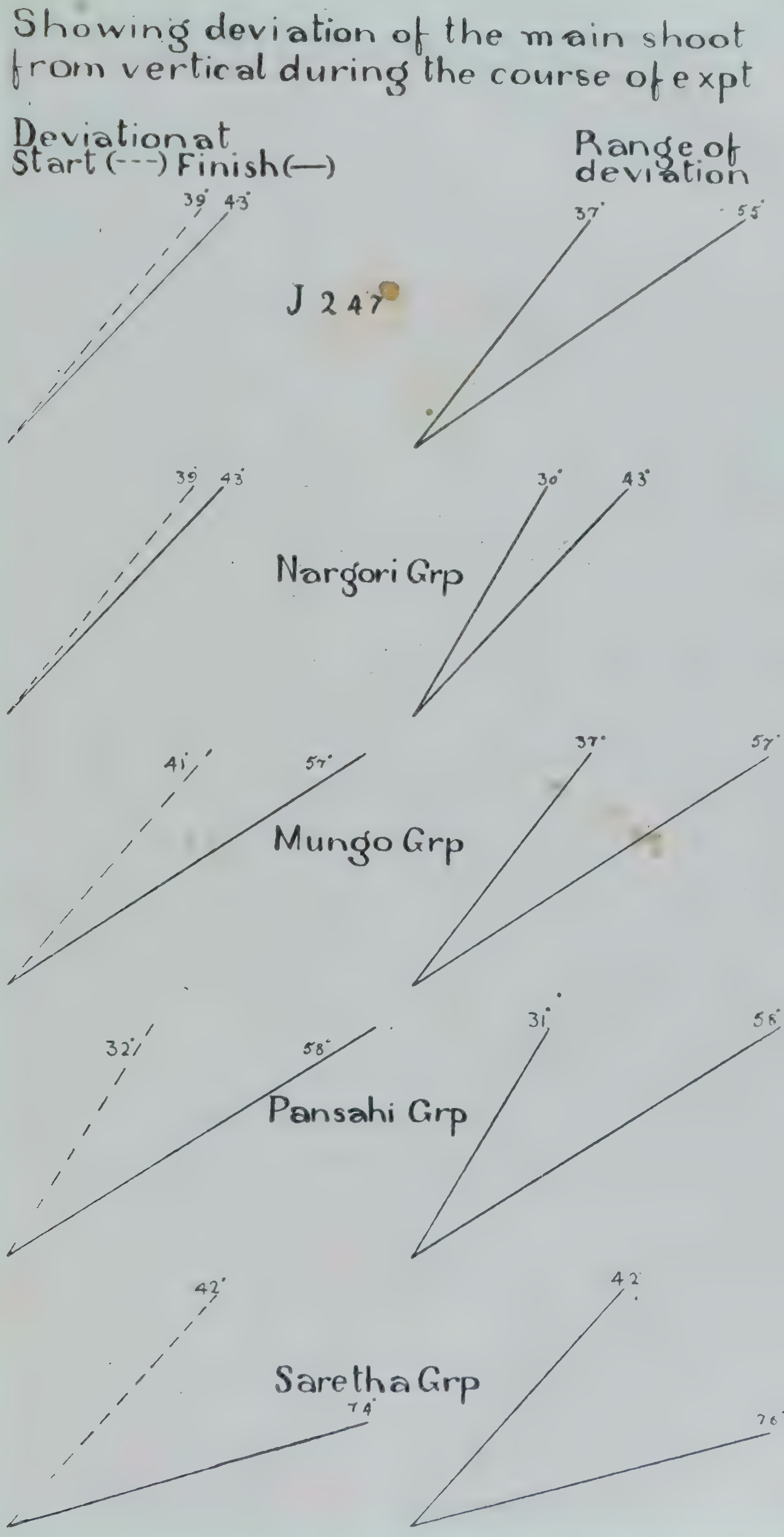
PLATE XXII.



Sugarcane buds planted in a tile pot with a lateral hole   Nos. 2 and 3 show the instrument used for measuring the angle of the main shoot.

CHART I.


Curves showing the position of the main shoot with reference to
the vertical from 15th to 87th day after planting
Saretha Group
Pansahi Group
Mungo Group
J 247
Nargori Group
Days of examination
Days 15-17
18-21
22-24
25-28
29-31
32-35
36-38
39-42
44-46
48-50
51-53
55-57
58-62
63-65
66-69
70-72
73-76
77-79
80-84
85-87
Deviation from vertical in degrees
80
70
60
50
40
30


Showing deviation of the main shoot from vertical during the course of expt
Deviation at Start (---) Finish(—)
Range of deviation
39° 43°
37° 55°
J 247
39 43°
30° 43°
Nargori Grp
41° 57°
37° 57°
Mungo Grp
32° 58°
31° 58°
Pansahi Grp
42°
42°
Saretha Grp
74°
76°

dissimilarity between the curve for the Saretha group and those for the other groups which have a comparatively good habit at harvest.

Chart II shows the angles as noted at the start and at the end of the experiment for each group and the range of variation noted for the different groups during the course of the experiment.

It is interesting to note that, in Nargori group, which has probably the best habit of all the indigenous canes, the angle of deviation is the least, and Saretha group, the worst habited of the indigenous canes, shows not only the greatest range, but is distinctly worse than the others, both at the start and at the completion of the experiment.

Straightness of canes at harvest in the different groups of indigenous canes.

For some time the straightness of canes at the time of harvest has been recorded at the Sugarcane Breeding Station. Besides detailed notes on the relative straightness of early or late canes, 100 canes of each variety used to be laid on the ground and a general note recorded on the lot as a whole. Detailed notes are available, but they fall roughly into three classes, *viz.*, (1) straight, *i.e.*, with little or no curvature anywhere ; (2) slightly curved, *i.e.*, showing a slight curving at the top or the base ; and (3) curved.

The table on next page gives the number of varieties classed under the three heads during the years 1917 and 1919 when the crop was grown in the same field. In the year 1918 the canes were badly lodged and so the notes are not reliable.

Erectness of varieties at harvest.

Group	Year	Straight: Straight	Straight: Straight below and slight curved above	Straight: Total	Straight: %	Straight: % Average for 1917 and 1919	Slightly curved: Straight below curved above	Slightly curved: Slight curved	Slightly curved: Slight curved below and curved above	Slightly curved: Total	Slightly curved: %	Slightly curved: Average for 1917 and 1919	Curved: Curved	Curved: Total	Curved: %	Curved: % Average for 1917 and 1919
J. 247 ..	1917	1	..	1	100·0	100·0	..	..	..	..	..	..	..	..	..	..
	1919	1	..	1	100·0		..	..	..	..	..		..	..	..	
Nargori ..	1917	14	..	14	82·4	85·3	..	3	..	3	17·6	14·7	..	..	..	..
	1919	6	9	15	88·2		1	1	..	2	11·8		..	..	..	
Mungo ..	1917	32	..	32	97·0	94·4	..	1	..	1	3·0	5·6	..	..	..	..
	1919	30	3	33	91·7		..	3	..	3	8·3		..	..	..	
Pansahi ..	1917	10	1	11	73·3	63·0	4	..	..	4	26·7	37·0	..	..	..	..
	1919	7	3	10	52·7		5	4	..	9	47·3		..	..	..	
Saretha ..	1917	..	1	1	4·3	4·3	..	13	..	13	56·6	45·7	9	9	39·1	50·0
	1919	1	..	1	4·3		..	8	..	8	34·8		14	14	60·9	

Fig 1. Nargori group showing good habit.

Fig. 2 Mungo group showing good habit.

Fig. 1. Pansahi group showing very fair habit.

Fig. 2. Saretha group showing bad habit with canes sprawling on the ground.

J. 247, Nargori and Mungo groups which show comparatively little variation in angles in the growth of the main shoot show a large number of varieties with straight canes. Saretha group is the worst and Pansahi group occupies an intermediate position. (Plates XXIII and XXIV.)

THE INHERITANCE OF HABIT IN SUGARCANE SEEDLINGS AND ATTEMPTS TO IMPROVE IT BY CROSSING.

Bad habit, in a seedling bred for North India, was early realized to be a possible evil to combat with and, if possible, eliminate, and attempts were made even from the start to collect data to determine the mode of inheritance of this character among the seedlings raised from the same parentage. One of the most startling facts, brought out from the raising of canes from seed, is the great diversity that is noticeable in seedlings raised from one and the same parent, and this may be said to form the main basis on which the production of a seedling better than the parent depends.

But through all this diversity in the resultant offspring there is often traceable a certain amount of broad similarity among the seedlings of one and the same parent; and this similarity often expressed itself in the form of a similar habit among seedlings of the same parent.

From the tables below it is seen that whereas the seedlings of the Saretha group (Plate XXV) show a particularly bad habit similar to that of the parent, those of the Sunnabile group, for instance, show a better habit agreeably to the better habit of the parents.

Inheritance of bad habit in seedlings of Saretha group.

Year	Seedlings	No. planted	Good habit	Fair habit	Bad habit	Remarks
			%	%	%	
1914–16 ..	Saretha G. C. ..	500	7·7	28·5	63·8	
	Do. Self ..	200	7·2	30·1	62·7	
1915–17 ..	Katha „ ..	100	17·8	53·4	28·8	Rather ill-grown.
	Kansar „ ..	100	16·9	40·5	42·6	Do.
	Lalri „ ..	100	22·8	38·6	38·6	Do.
	Mesangen „ ..	100	15·3	47·0	38·7	Do.
	Saretha „ ..	100	4·5	58·4	37·1	Do.
1917–19 ..	Ramui G. C. ..	100	8·3	25·0	66·7	

Inheritance of good habit in seedlings of thick canes and Sunnabile group.

Year	Seedlings	No. planted	Good habit	Fair habit	Bad habit	Remarks
			%	%	%	
1915–17 ..	Red ribbon G. C.	100	39·0	45·7	15·3	Parent has good habit and a thick cane.
	J. 247 ..	200	45·3	48·0	6·7	Do. do.
1917–19 ..	Putli Khajee ..	100	14·3	79·6	6·1	Parent habit fair, belongs to Sunnabile group.

It is however fortunate that by a suitable crossing it is found possible to influence the habit of the resultant seedlings. The table hereunder shows that the habit in seedlings is, to some extent, controllable by proper selection of the pollinating parent, though it should here be mentioned that the peculiarities of the sugarcane flowers makes it impossible to attempt this improvement of habit in all cases.

Influence of crossing on habit.

Year	Parentage	No. of seedlings planted	Good habit	Fair habit	Bad habit	Remarks
			%	%	%	
1916–18..	Mauritius 1237 × M. 4694 ♂ ..	200	75·5	21·6	2·9	M. 4694 habit good
	Mauritius 1237 × M. 7319 ♂ ..	50	75·0	25·0	..	M. 7319 habit good.
	Mauritius 1237 × Saretha × S. Spt. ♂	150	39·0	51·7	9·3	Sar × Spt. bad habit.
1917–19..	J. 213 × Java ♂ (Hebbal) ..	140	1·1	75·3	23·6	Java fair habit.
	Do. × Purple Mauritius ♂ ..	100	0·0	70·6	29·4	P. Mauritius fair habit.
	Do. × Katha ♂	100	0·0	47·1	52·9	Katha bad habit.
	Do. × Kansar ♂	100	2·6	50·0	47·4	Kansar bad habit.
	Do. × Saretha ♂	100	0·0	40·7	59·3	Saretha bad habit.

Note.—Mother Mauritius 1237 has a good habit but it gave no selfed seedling because of infertility of its own pollen.

J. 213 has fair habit but it gave no selfed seedlings because of infertility of its own pollen.

My thanks are due to Rao Sahib T. S. Venkatraman, B.A., Acting Government Sugarcane Expert, for giving me all facilities and encouragement.

Fig. 1. Katha and its seedlings. Note bad habit in both.

Fig. 2. Pansahi and its seedlings. Note the good habit.

Selected Articles

THE GROWTH OF THE SUGARCANE.*

BY

C. A. BARBER, C.I.E., Sc.D., F.L.S.

III.

THE presence of roots and shoots on the joints of the cane at crop time is, as we have seen, unwelcome. The new growths are of course useless for sugar making, and their presence in quantity lowers the purity of the juice at the mill. Besides this, all the joints in the neighbourhood of lateral shoots have a good deal of their stored sucrose changed into glucose, which is the form in which sugar travels to supply the material for fresh growing parts. We traced the formation of shoots and roots to climatic causes, chief among which was an excess of moisture, to lodging, to any check in the growth of the cane, whether by insect or fungus attack or accidental breakage, or, lastly, to the canes flowering some months before harvest time. We also noted that some varieties of cane are more prone to shooting than others. It is a very common phenomenon in diseased plants. In some cases the habit and general appearance of the bunch is entirely changed, and, in place of a few upright, clean canes, hundreds of small, grass-like shoots make their appearance (Fig. 1). This abnormality is apparently due to the most various causes. It is supposed to be induced by various insects and fungi, by eelworms in the roots, general malnutrition, and the presence of alkali in the soil ; but it is often impossible

* Reprinted from the *International Sugar Journal*, December 1919.

to fix the responsibility on any one circumstance. It will be remembered that it is one of the features of the mysterious *sereh* disease which devastated the Java cane fields towards the end of the last century. The writer has met with a case in India where in a couple of acres, planted with cane for the first time, and in apparently ideal surroundings, after 14 months' growth only an

Fig. 1. A plant with many small shoots in place of a few healthy canes.

occasional isolated cane could be seen, and the whole field looked very much like one of *Guinea grass*. A thorough examination of

the tissues of the affected plants, both above and below ground, showed no sign of unhealthiness or any trace of insect, fungus or eelworm. The subject requires further study to determine the fundamental condition of the plant's economy which leads to this enormous development of shoots, which is in many respects similar to the "spike" disease of sandalwood.

But to resume our main study of sugarcane growth. To properly understand this under field conditions, it is necessary to examine the constitution of the bunch of canes derived from a single planted set, and this is especially the case when we come to consider the tillering power of different varieties. We have seen that the piece of cane planted has several joints, and that each of these joints has a bud which is capable of producing a complete plant. The bunch of canes in a single "hole" where one set has been planted may thus consist of one or more plants, according to the number of buds which "germinate." The number of separate plants in a bunch and their relative size and importance can only be determined by dissection. This is a tedious and difficult operation, for the lowest parts of the canes, where they are attached to their mother stems, are often thin and brittle, and furthermore, the whole underground part of the bunch is enveloped in an intricate weft of tough, fibrous roots, dead and living, which have to be cut away before the details of the branching can be laid bare. An example of such dissections is shown in Figs. 2, 3, and 4. In Fig. 2 a bunch of canes has been photographed as it was lifted out of the ground, with all the soil carefully picked and washed away, but the free spread of the roots is somewhat obscured by the pressure of the bunch upon them. Upon dissection, this bunch was proved to consist of four separate plants, which are shown in Figs. 3 and 4. In these four plants there were 7, 9, 4, and 8 canes, respectively, making a total of 28 for the whole bunch. The latter was only nine months old when taken out of the ground, but experience of many dissections has shown that no shoot not already forming cane at its base at that time can develop rapidly enough to be of use in the crop, and only such have been taken into account. The result, then, of planting a single set has been that four plants

were produced, with an average of seven canes each at harvest. The bunch was of the *Mungo* group of Indian canes.

Fig. 2. A bunch of *Mungo* canes arising from a single set. This is a dwarf variety with very short joints. The root system is poorly developed and not fully shown.

There are many lessons to be learnt by thus laying bare the whole branching system of a bunch of canes. It is easily seen that the individual canes are not of the same age. Some are formed very early in the life of the plant, while others have, so to speak, been produced at the last moment, and have barely time to complete their growth by harvest. Some of the main shoots are produced by the out-growth of the buds on the set, while others are branches of branches of these. As we know from our chemical analyses that the character and richness of the juice varies a good deal during the

life of each cane, gradually increasing until an optimum is reached and then declining, it becomes necessary to carry our examination further, and determine the whole scheme of branching. In the example given above, we must determine the relative stage of development of each of the 28 canes forming the bunch, and its correct position in the scheme of branching. Assuming, as a basis, that each shoot, if it develops unhindered, will produce one cane, we may divide them into classes on completing our dissection.

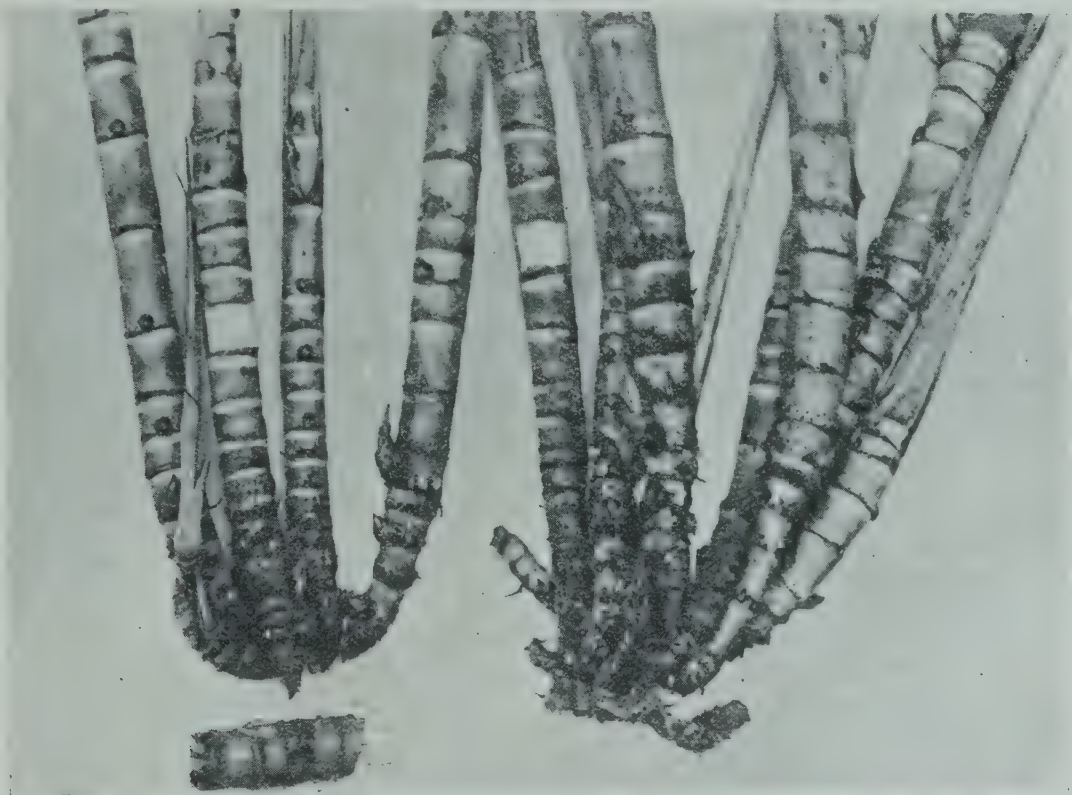


Fig. 3. The bunch in text-figure 1 dissected out to show that it consists of four separate plants arising from different buds on the set. In each plant the "mother" cane is indicated by a piece of white paper wrapped round it.

The shoot which is the direct outcome of a bud on the set is the main axis of the plant: this we term the "mother" cane and designate it by the letter *a*. Shoots formed from buds on the joints of *a* are branches of the first order, and we name them *b*1, *b*2, *b*3, etc., in the order of their arrangement from below upwards. Similarly, the branches on *b* are of the second order and marked *c* and so on with *d*, *e*, etc., as far as they appear. In the bunch of canes photographed, the four plants have the following constitution :— $a + 3b + 3c$, $a + 2b + 5c + d$, $a + 2b + c$, $a + 3b + 4c$.

Taking the whole of the canes of the bunch together, we have $4a + 10b + 13c + d$, and if we made enough dissections and calculated the resulting formulæ of the different plants, we could obtain an

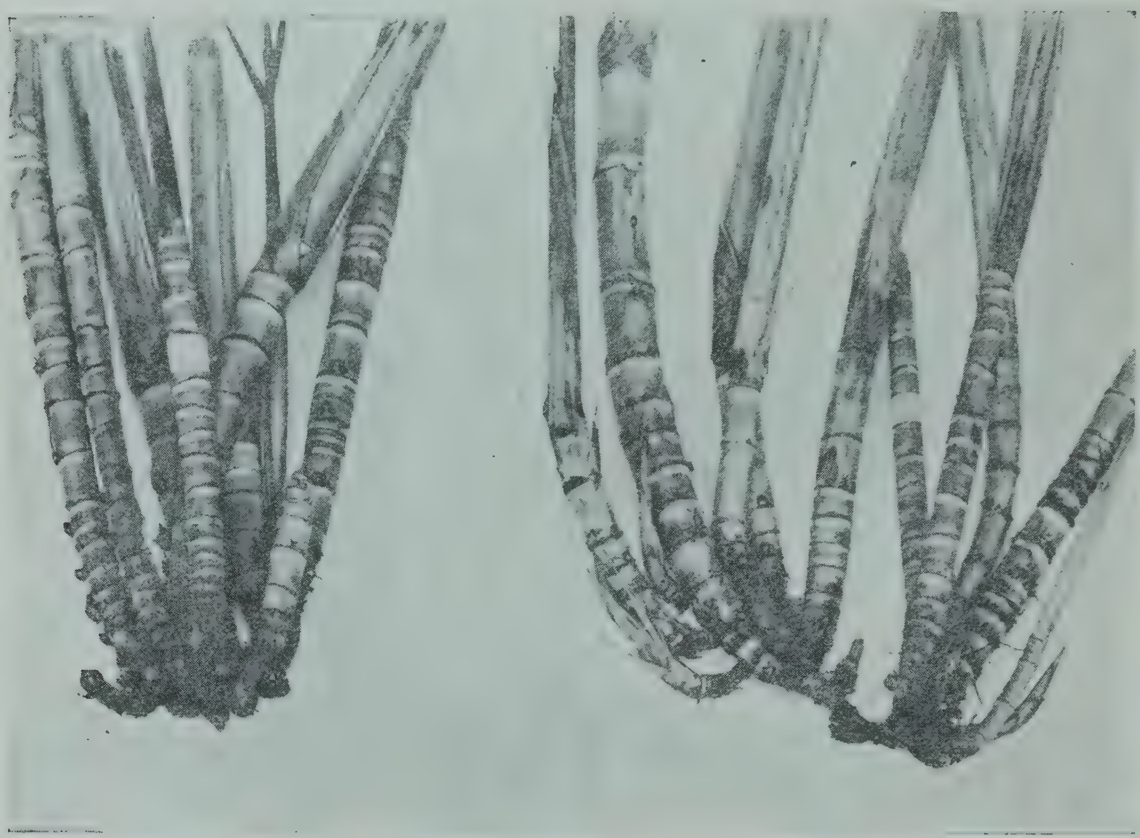


Fig. 4. The bunch in text-figure 1 dissected out to show that it consists of four separate plants arising from different buds on the set. In each plant the "mother" cane is indicated by a piece of white paper wrapped round it.

average constitution of a typical plant of the group. As a matter of fact, this has been done. Fifty-nine dissections were made of cane plants in the *Mungo* group, and the average formula for these 59 works out as $a + 2b + 2c + d$.

A study has recently been made of many other groups of canes[1] and the result of this shows that, while there are extreme variations in the formula of individual plants, the greater the number of dissections, the simpler the average formula becomes. In the following table some of the results of this study are summarized. In the first column the actual averages obtained in the dissections are recorded, in the second the theoretical formula of branching is put down, which, it is presumed, would be reached by the plants

[1] Barber, C. A. "Studies in Indian Canes, No. 4. Tillering or Underground Branching," *Memoirs of the Department of Agriculture in India, Botanical Series*, Vol. X, No. 2, June 1919.

if they had been grown in more ideal surroundings. It is obvious that, for this kind of study, all the varieties had to be grown under uniform conditions side by side in one place. And, as the place chosen was in many cases far removed from their natural habitat, climate, and soil, they did not grow as well as they were capable of doing. The dissections were made at the Coimbatore Cane-breeding Station in South India :—

Formulæ of branching of different groups of canes.

Group of canes	Number of plants dissected	Average of dissections						Theoretical formula					
		a	*b*	*c*	*d*	*e*	*f*	*a*	*b*	*c*	*d*	*e*	*f*
(1) Wild grasses—*Saccharum arundinaceum*	5	1	4	6	6	5	0·4	1	4	6	6	4	1
Saccharum spontaneum	17	1	4	7	5	2	0·4	1	4	6	6	4	1
(2) Indian canes—*Pansahi* group ..	29	1	3	4	2	..	..	1	3	4	3	1	..
Mungo ,, ..	59	1	2	2	1*	..	..	1	2	3	2	1	..
Saretha ,, ..	53	1	3	3	1	..	..	1	3	3	1	..	..
Nargori ,, ..	33	1	3	3	..	..	..	1	3	3	1	..	..
Sunnabile ,, ..	46	1	3	2	..	..	..	1	3	3	1	..	..
(3) Thick, tropical canes grown in India ..	41	1	2	1	..	..	..	1	2	1	..	..	..

* The formula for the *Mungo* group is reduced here because the varieties are dwarf canes with very short joints ; there are, therefore, more plants in a hole than in the other cases. As many as 7—11 plants were sometimes included in a bunch, and the branching of these was consequently small. By using another method the actual average obtained was 1, 3, 3, 2.

We learn from this piece of work that there is a good deal of difference in the branching powers of different groups of canes. The wild *Saccharums* head the list, and, as the cultivated canes (*Saccharum officinarum*) must have arisen from a wild ancestor, the former have been included. The branching of the wild *Saccharums* is the most prolific. The indigenous Indian canes come next, and can be roughly divided into two sets. *Pansahi* and *Mungo* branch a great deal, *Nargori* and *Sunnabile* much less wherever they are grown. *Saretha* in its native habitat (the Punjab and adjoining portions of the United Provinces, where tropical canes cannot, as a rule, mature) would belong rather to the *Pansahi-Mungo* set, although the dissections show a formula similar to that in *Nargori-Sunnabile*. Lastly, the thick, tropical canes branch least. It is a matter of common observation that their tillering

power is much less than that of Indian canes, and this is clearly brought out in the table. It should, however, be stated that the tropical canes grown on the farm were no more at home than the North Indian varieties. It would be difficult to find a place which suits both of these classes of cane plants. A set of 12 bunches of well-grown tropical canes was dissected on an estate in South Arcot, where they are grown successfully on a large scale for sugar manufacture. They belonged to the Red Mauritius variety, which is known as a free tillerer, and the object aimed at was to determine the possible branching of thick canes grown on an estate scale in India. The average of these 12 selected bunches gave the formula $1a + 3b + 3c + 1d$, and this may, perhaps, be a more general formula for canes grown in the various sugar growing countries in the tropics. It may be of interest, in conclusion, to point out that the Yuba cane of Natal, a member of the *Pansahi* group of Indian canes, was one of those included in the dissections. A good deal of attention is just now being paid to this hardy, primitive variety, and the extended formula of its branching system is undoubtedly one of its main attractions.

NOTE ON THE EXHAUSTION OF INDIAN SOILS AND THE METHODS BY WHICH THIS MAY BE REMEDIED.*

BY

R. V. NORRIS, D.Sc.,

Government Agricultural Chemist, Madras.

As a result partly of war conditions and of the shortage of grain stuffs resulting from the failure of the monsoon a year ago a good deal of attention has recently been paid to the present condition of Indian soils and the crop-yields obtained from these. The results of such investigations have tended on all sides to demonstrate that a very serious impoverishment of these soils is taking place and that energetic steps are necessary to remedy this state of affairs.

Let us consider for a moment the changes taking place in the soils. We know that the various plant foods, nitrogen, phosphates, potash, etc., may exist in the soil in a number of different forms. Some of these will be present as compounds which are of immediate use to the crop, others require to undergo various transformations before they can be taken up by the plant. The former class we describe as the "available" plant food, the latter as the "unavailable." The second term is of course a relative one, because, as I have explained, a certain proportion of the unavailable material slowly undergoes change and becomes available. Now how does this influence the crop? It is obvious of course that while there is a plentiful supply of available plant food the soil will be fertile and other conditions being favourable good crop-yields will be

* Paper read at the Madras Agricultural Conference, 1919. Reprinted from the *Journal of the Madras Agricultural Students' Union*, December 1919.

obtained. If this food supply however is not maintained by the addition of appropriate manures there will be a regular falling off in yield until eventually a state of balance is reached when the plant food removed in any given crop is equal to the amount of unavailable food rendered available during the time of growth. The yield obtained under such circumstances is of course very low and we refer to it as the "minimum cropping value of the soil." Owing to the relatively large reserves of plant food present in practically all soils, this low figure will remain practically unchanged for very prolonged periods. I have gone into these very elementary details of soil chemistry with which most of you are entirely familiar because it is sometimes argued that since many Indian soils go on producing year after year a fairly constant yield there is really little cause for anxiety. You will readily see that such an argument is fallàcious. It simply means a very large proportion of these soils have already reached this minimum cropping value which I have just described, that is to say they are producing year after year crops far below those which could be raised after reasonable manurial treatment.

Now to meet the shortage of food stuffs to which I have already referred, there has been a vigorous demand in many quarters for the adoption of more intensive methods of cultivation and for the introduction of heavier yielding strains. Now both of these are eminently desirable things, but it is necessary we should realize one result of their adoption. It is perfectly obvious of course that the introduction of more prolific strains means we shall remove plant food from the soil at an increased rate. Similarly by more intensive measures of cultivation we shall increase the rate at which our reserve plant foods are brought into use and lead in this way to a more rapid depletion of our stocks. In other words, both these methods alone while giving us a momentary greater return will, unless accompanied by proper manurial treatment, eventually lead only to a still greater exhaustion of the soil and the final yield will again fall to the minimum value. The more intensive our methods therefore and the more prolific the strains we employ, the more imperative is the necessity for an extended and judicious use

of fertilizers. It is obvious that these fertilizers must be used in a systematic and rational method. If a soil is deficient in both nitrogen and phosphate such a soil will derive but little benefit from the application of nitrogen alone as the crop would still be limited by the phosphate deficiency. We may say then that usually general manures will be required, prolonged treatment with a manure containing one particular type of plant food only leading to a more rapid exhaustion of the other forms of plant food and hence ultimately to a reduction of fertility.

It is probably not generally realized to what extent soil exhaustion in India has already proceeded, so I may give one or two figures to illustrate the point.

In Madras we have during the last few years been engaged in a soil survey of the paddy lands of the Presidency and up to the present time have completed such a survey in four of the chief deltas, namely, Guntur, Tanjore, Kistna, and Godaveri. This survey has had as one of its principal objects merely to ascertain how far these soils are in need of immediate manurial treatment. The results are certainly instructive. Considering first the Godaveri Delta, which is generally considered to contain some of the most fertile land in the Presidency, we find nevertheless that 23 per cent. of the samples analysed show a deficiency in available phosphate and 40 per cent. or nearly half the delta a deficiency in nitrogen content.

The Kistna Delta gives slightly worse figures, 33 per cent. of the samples exhibiting phosphate starvation and 55 per cent. lack of nitrogen.

In the remaining two deltas the situation is even more serious, the figures being as follows :—

	Deficient in nitrogen	Deficient in phosphate
	Per cent.	Per cent.
Guntur	81	33
Tanjore	87	80

Comment on such figures is hardly necessary and there is no reason to believe that many of the other paddy lands of the

Presidency are in any better condition. If we remember that an increase of 5 per cent. only in the average yield would provide an extra 1,000,000 tons of rice a year in Madras alone, we can realize to some extent what the annual loss is in the whole country in this and other crops.

Examples such as the above could be brought forward in numbers. Clouston, in a paper read at the Indian Science Congress in 1918, stated that the four chief soils of the Central Provinces had in most districts reached a state of maximum impoverishment. In one of his experiments by an outlay of Rs. 33 per acre on manures in cane, the net profit per acre was increased by no less than Rs. 146, *i.e.*, over 400 per cent. the cost of the manure applied. In a similar way Davis has emphasized the critical condition of many of the Bihar soils as regards phosphoric acid content.

We may then, I think, take it as a fact that a very large number of Indian soils are already exhausted or approaching that state. We must pass on to consider what are the chief requirements of such soils and the reasons why under present conditions these requirements, urgent as they are, are being met to such a small extent.

In the examples I have quoted, we have seen that the deficiency chiefly consists of nitrogen and phosphates and this may on the whole be considered as applicable to the whole of India though certain districts—of which the Nilgiris and Malabar are examples,—are also extremely deficient in lime. Let us consider first of all the nitrogen question. Now nitrogen, like other plant foods, exists in the soil in available and non-available forms, the most available form, nitrates, being produced from complex nitrogenous compounds in the soil by a series of changes terminating in nitrification. Sometimes however these changes take another course and in this way an accumulation of relatively unavailable nitrogenous material may take place of which a familiar example is the production of peat. By cultivation we produce conditions, however, which are favourable to nitrification. One result therefore of the intensive cultivation to which I have already referred will be to accelerate this conversion of unavailable nitrogenous material into nitrates, and unless appropriate measures are taken, the reserves being

used up at a rapid rate, exhaustion will occur. Such cultivation moreover has another disadvantage. It is well known that under suitable conditions very large quantities of nitrogen can be added to the soil from the atmosphere by the agency of nitrogen-assimilating bacteria. But these bacteria require the presence in the soil of considerable amounts of carbonaceous organic matter. Hence if by our intense cultivation we use up at a rapid pace this organic matter in the soil we shall thereby at the same time diminish this valuable fixation of nitrogen.

It is obvious therefore that we must combine such methods of cultivation with liberal supply of manure, and for the reasons I have stated, bulky organic manures such as farmyard manure, *poonacs* and fish manure are peculiarly suitable to the conditions prevailing in this country. Such manures moreover have a further advantage as compared with more concentrated manures in that they improve to a marked degree the mechanical condition of the soil whereas the concentrated chemical manures have a tendency in the opposite direction.

It is particularly unfortunate therefore that the manures to which I have referred are precisely those which for various reasons are either being sent out of the country or else used in a wasteful manner. In the first place, the best use is not made of the manure most generally available, *viz.*, farmyard manure. In many districts this is used mainly as fuel resulting in a total loss of nitrogen. Even if this be not done the manure is almost invariably stored in such a way that at least 60 per cent. of the nitrogen is not utilized. Little effort is made to collect the liquid and more valuable portion of the manure or to protect the manure pit in any way, with the result that the aggregate loss in manurial value is enormous.

There is no doubt that many ryots at present do not realize the value of manures. This is a factor which time alone can remove but the ryot is a shrewd judge in many ways, and when once convinced by demonstration of the benefits to be derived he will not be slow to take up the use of manures. This has been shown in a striking way by the largely increased demand for fish guano even in districts remote from the source of supply. But assuming that

the ryot is fully convinced of the value of manure and anxious to obtain these, the price of most fertilizers has reached a figure which puts them quite out of reach of the small cultivator except in the case of the most profitable crops. The reason for this is the high price which manures such as oil-cakes and fish command in the foreign market resulting in a large export trade and a rise of price in this country.

Fish manure containing as it does a good percentage of both nitrogen and phosphate is particularly suitable to our soils and yet the export is increasing rapidly. In February of this year Colombo was paying Rs. 160 per ton for fish guano and consequently was attracting the bulk of this commodity which a year or so before was obtainable at Rs. 45 a ton ex-factory. This export is likely to continue, therefore, with a consequent increase in price in spite of the fact that the production of fish manure is necessarily limited and quite insufficient to meet the manurial requirements of the country.

When we come to consider the case of oil-cakes we find again exactly the same conditions prevailing. These cakes, though they contain sometimes a fair amount of phosphate, must be regarded chiefly as nitrogenous manure. Now the oil-seed crops are notoriously exhausting to the soil. But if the seeds were crushed and the resulting cake either applied to the land directly or in the form of cattle manure after feeding, there would at least be some return of plant food to the soil. But the tendency is all the other way. Not only has the export of oil-seeds steadily increased, but even in those cases where the seeds have been crushed in this country a large amount of cake is exported. The figures are instructive. Taking the normal years immediately preceding the war, the export figures for the whole of India were approximately as follows:—

1913–14	All India	Tons	Value
			£
	Whole oil-seeds	1,572,792	17,000,000
	Oil-cakes	175,000	1,000,000
	From Madras alone.		
	Oil-seeds	....	3,500,000
	Oil-cakes	....	400,000
			(approximately).

This has naturally led to a great increase in cost and the state of affairs is likely to become worse owing to the intense demand for such products at the present time in European countries. Hence it is not surprising to find that the present price of groundnut cake is about Rs. 140 per ton or three times the price for which it could be obtained a very few years ago. It is impossible for the average ryot to pay such prices and it is in my opinion essential that steps should be taken to remedy this state of affairs. It would therefore appear necessary to prohibit entirely the export of fish manure of which the supply is so limited and to impose an export tax on oil-cakes in order to retain a large quantity of these in the country. With regard to whole oil-seeds also a heavy export tax should be imposed. In this way the oil-crushing industry could be developed in India, the oil being freely exported but the residual cake being consumed as far as required in this country. Two causes have hitherto tended to retard the development of oil-crushing in this country. The fact was that when oil-crushing was introduced, owing to the wholesale adulteration which took place Indian oils obtained a thoroughly bad reputation. Secondly, European countries have imposed an import duty on oil while allowing free entry to whole seeds and cake. The remedy for the first is obvious; in regard to the second, the conditions in Europe are such that it is doubtful whether these duties would be maintained if the supply of whole seed were restricted. Hence the times are now particularly favourable for such a change.

So far we have been considering nitrogenous manures. In the case of phosphates the situation is much the same. The chief phosphatic manures available in this country are bones, fish manure, and deposits of mineral phosphate. With fish we have already dealt. In the case of bones we again find a large export taking place. Owing to the war, the figures for the last few years have been erratic, but in normal times bones to the value of over 4 lakhs of rupees were annually exported from this Presidency alone chiefly to Ceylon. As a result of this external demand the price has steadily risen and early this year the excessively high figure of Rs. 130 per ton was being quoted in Ceylon for bone meal. This is therefore another

case where export should be totally prohibited. The bones retained in this way could readily be crushed at a large number of centres because many land owners are already in possession of oil engines which are not fully employed and which could therefore be used with advantage to drive small disintegrators. In this way bone meal, which has given good results in this country, would be available at a greatly reduced cost.

In the case of mineral phosphate deposits in this country we are at present in some doubt as to the best method of utilization. They are not suitable for the preparation of superphosphate and when used alone the availability is of a very low order. A considerable number of experiments have been carried out here to increase their availability by using the crushed mineral phosphate in combination with organic matter. The experiments have been sufficiently successful to indicate that a satisfactory method of utilizing these deposits will probably be found, but it cannot be said that the correct conditions have yet been realized.

Quite recently claims have been put forward regarding a phosphatic manure termed "tetra phosphate" which is prepared in a very simple way from rock phosphate. These experiments have been carried out chiefly in Italy and in my opinion the evidence is not particularly convincing. In view of the importance of utilizing our supply of phosphate we are, however, at present carrying out trials to test this new method on the Trichinopoly deposits, but the experiments are not yet sufficiently advanced to indicate the probable result.

One other possibility has lately arisen in connection with such deposits. Very favourable results have been obtained in America by the use of ammonium phosphate. Such a fertilizer, containing as it does about 13 per cent. of ammonia and 40 per cent. of soluble phosphate, would probably be particularly suitable for the conditions prevailing in South Indian soils. The possibility of utilizing the Trichinopoly deposits in such a way depends entirely on the cost of production and this will again depend largely on the production of cheap ammonia which is quite a feasible proposal in this country. At any rate the prospect opens out a promising field of enquiry.

While dealing with future possibilities I may also refer to the use of what is known as "activated sludge," which is the final deposit obtained in the most recent method of sewage disposal. The substance when dry contains about 6-7 per cent. of nitrogen instead of the 1-2 per cent. in the older product and may eventually therefore form a valuable manure in the neighbourhood of large towns where such a system will sooner or later will have to be adopted.

We dealt so far with the indigenous manures of the country and we must finally consider how far we can make use of synthetic methods for utilizing the nitrogen of the atmosphere to make nitrogenous fertilizers. There are three or four ways in which this is now being done in other countries. First, there is the Arc method in which by means of a powerful electric arc the oxygen and nitrogen of the atmosphere are made to combine to form nitric acid. This requires very high powers and large production to be profitable and will not, I think, be practically suitable for Indian conditions. Secondly, we have the Haber process for synthetic ammonia by which hydrogen under the influence of a catalyst is made to combine with atmospheric nitrogen to form ammonia which can then either be converted into ammonia sulphate or further oxidized to nitric acid. This is one of the cheapest ways of producing ammonia and enormous quantities of ammonium sulphate are now being manufactured in this way so that there is a considerable likelihood of a considerable fall in price as regards this fertilizer. This probability is increased by the report recently published of an important improvement on this process which will considerably reduce the cost of production. The process, however, requires skilful supervision and will not therefore be particularly easy to establish in this country. Lastly, there is the cyanamide process in which atmospheric nitrogen is passed over heated calcium carbide with the formation of calcium cyanamide, a valuable nitrogenous fertilizer, which is also easily capable of conversion into ammonia. The requisite materials for this process are supplies of limestone, fairly pure charcoal and reasonably cheap electric power and it is likely to be the best adapted for use in this country.

There is no doubt ample scope and opportunities for the development of such industries in India. Not only are the fertilizers produced of the greatest value in themselves but they could be used in combination with *poonacs* of poor quality such as *pinnai* or *dupake* cake which at present can be profitably used alone.

It may be remarked in passing that a new nitrogenous fertilizer has recently received much attention, *viz.*, ammonium nitrate, which was largely used in the war as a constituent of explosives. The advantage of this compound is that it contains nearly 35 per cent. of nitrogen and so is the most concentrated nitrogenous manure made, a factor of value where transport has to be considered.

I hope I have now been able to show that it is possible by the methods indicated, *viz.*, restriction of export of *poonacs*, uncrushed oil-seeds, bones and fish manures and by the development of the processes for the synthetic production of nitrogenous manures, to reduce very considerably the price of manures in this country. I have only time to refer very briefly to the other measures necessary to ensure the best use of the materials thus made available. The first necessity is the further education of the ryot. As I indicated, this is not so difficult as sometimes supposed and machinery already exists for such work and only requires expansion.

Secondly, the cost of transport must be reduced to a lower figure. Hence co-operative purchasing is indicated in order that manures may as far as possible be carried in bulk with consequent reduction in freightage rates. For similar reasons purchase in bulk is necessary in order to obtain favourable terms, and this means credit must be provided. There is therefore a large field here for the development of co-operation.

Finally, there is the difficulty, and it is no small one, of the present system of land tenure in many parts of the country. So insecure is the position of the tenant that he cannot reasonably be expected to sink capital in improvements from which he himself may obtain but little benefit and for which, if evicted, he can claim no compensation.

The whole question therefore is by no means a simple one but the time is quickly approaching when it will have to be faced in a

reasonable manner. The population is increasing rapidly and I believe that the enhanced production required can only be brought about by a determined effort to increase the *permanent* fertility of the soil by reasonable manurial treatment. At present there is a tendency to face it in another way by the attempt to bring into cultivation large areas of more or less unprofitable land, but judged only from the point of view of production this can have but little permanent value and cannot be regarded as anything but a palliative of a temporary nature.

Summary.

The situation may then be summed up briefly as follows :—

1. A large proportion of the soils of the country are already suffering from starvation or are approaching that state.

2. The supply of indigenous manurial products is being sent out of the country at an increasing rate with the result that the price is now prohibitive to the small cultivator.

3. Such a deficiency must be met by (*a*) limitation of export of such materials ; (*b*) increased production of synthetic nitrogenous manures, in which methods based on the cyanamide process would appear to be most likely of success in this country ; (*c*) development of processes for the utilization of the phosphatic deposits of the country.

4. In order to utilize the increased supply of manurial substances, attention must be directed to (*a*) education of the ryot to realize their value ; (*b*) development of co-operative buying and transport ; (*c*) revision of land tenures where these do not give the tenant a sufficient margin of protection.

THE POSSIBILITIES OF CITRUS CULTURE IN INDIA.*

BY

A. H. WITTLE,

Of "Orchard Dene," Yercaud.

Much interest has been awakened in recent years in the cultivation of fruit and the production of articles of consumption previously imported. There is no doubt that, if the subject was better understood and the knowledge properly applied, the greater proportion of the money paid to outside producers might be kept in the country, not only to the material economic advantage of India, but also from a health point of view.

India—and I may even confine my statement to apply to the Madras Presidency—with its varying altitudes and climate is, in my opinion, as near as possible, ideal for the cultivation of almost every known variety of fruit, and what with the ever improving economic position of the majority of Indians, combined with Government assistance in opening up an experimental jam and preserve factory on the Nilgiris, there is, and always will be, a growing demand for really well-grown fruit.

At the present time, demand is undoubtedly outpacing the supply.

Apart from the urgent need for fresh fruit, there is also a growing demand for preserves, cool drinks, etc., such as marmalade, candied-citrus peel, raw and sweet lime juice, citric acid, crystals for mineral waters, and citrate of lime which is used in its crude form for bleaching certain kinds of linen. Also other bye-products,

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which, owing to simple methods of manufacture, could easily be made in this country by any intelligent ryot, after receiving a few lessons from an expert of the Agricultural Department, and it is my good fortune to know how keen the officials of the Agricultural Department are, in every branch, to help one and to give valuable advice merely for the asking.

What with cheap labour, combined with a few simple and effective appliances for cultivation, and given facilities for irrigation where necessary, and average good land—such as is met with more or less all over the country—with an addition of fertilizers intelligently applied, we should not only be capable of producing enough first class fruit for our own requirements, but could compete most favourably with other exporting countries on the European markets.

The most suitable places in South India for citrus culture would be parts of the Nilgiris, Shevoroys, Kunnamalais and many other hills, the Malabar Coast, Wynaad and, in fact, almost anywhere where there is good soil and ample rainfall, say, from 60 to 120 inches average, or where irrigation is available.

Citrus fruits do best in a deep, loamy soil rich in humus and the essential plant foods, but it has been my experience that almost any soil can be made to grow good, healthy fruit trees; with proper preparation of the soil before planting and what with cheap labour and suitable implements, which are available in the country at present, it is not a very difficult or expensive matter to bring some of the most intractable and apparently indifferent looking soil into a fit state to grow excellent fruit trees. It is merely a matter of thoroughly working, and in some cases, sub-soiling, draining, and ploughing in one or two green manure crops and adding suitable fertilizers, and the trees—other things being equal—will not only grow well, but very soon bear paying crops.

Now to the question of the right kind of plants to propagate or purchase:—Cheap trees, merely because they are cheap, usually prove to be the most expensive in the long run; therefore, purchase your trees from a reliable nurseryman and pay him a fair price for the very best trees he can produce. You may be told that two

or three year old plants, such as one sees in nurserymen's show gardens, and which are usually covered more or less with fungi of sorts, trying to grow in a 6-inch flower-pot, will make excellent growth when planted out, and will bear fruit in one or two years. These plants are sold at a low price and are usually not worth paying freight on. It is more economical to pay a good price for really well-grown healthy plants free from leaf and other diseases and also guaranteed true to name and thus avoid the possible dissemination of virulent plant diseases. It is to be hoped, now that the Pest Act is in force, Government will consider the necessity of inspecting plants offered for sale in every nursery in the country, and no one should be allowed to sell plants to the public without first obtaining an annual certificate of cleanliness from an authorized Government expert. I know a case where a man spent a considerable amount of money on citrus plants which were covered with a most destructive fungus disease and, had it not been that he procured advice, and had not the plants been properly treated in time, he would have lost the whole of them and, worse still, would have given up in despair an enterprise which has since proved a most remunerative undertaking, thinking that either the climate or soil was unsuitable.

As regards suitable varieties, there are many, and, on looking through a catalogue, one is often bewildered by the host of varieties named, all—or nearly all—of which appear to have special merits. As India is the home of citrus tribe, it would be as well to consider the best of those usually grown in the locality, such as the Nagpur *santara* orange, the Sylhet, and in South India, especially in Coorg, that which has come to be known locally as the Coorg orange, are perhaps three of the best. Of imported varieties, there are Washington Navel, Navelensia, Mediterranean Sweet, Paper rind, St. Michael Joppa, and Valencia late—to mention only a few of the best; there is Sevill orange (*C. vulgeris*) and sometimes called *C. bigardia* or bitter orange, which is used extensively in the manufacture of marmalade and also for the extraction of essential oil from the rind, leaves and flowers, which is used as a base in the manufacture of some of the most expensive perfumes and also for

the manufacture of citrate of lime from the juice. A sample taken from this variety growing locally was found to contain 9 oz. of citric acid crystals per gallon of juice.

The citron (*C. medica* sp.), the rind of which is used in the manufacture of the candied peel of commerce, and for which there is a large demand. Juice of this fruit also has been tested and found to contain over $7\frac{1}{2}$ oz. of citric acid per gallon of juice.

The Pomelo (*C. decumana*), which is sometimes called the Shaddock, grape fruit, etc. Apparently there are three varieties of this fruit grown in South India, although none of them could by any stretch of imagination be considered to resemble a grape in taste. There is no doubt, however, that there is more than one variety of this fruit which is really delicious when prepared by extracting the bitter membrane and sprinkling the pulp with sugar. I have it on the authority of an expert in such matters that it is a delicious and refreshing fruit to eat early in the morning. There is no doubt that if this fruit with its vigour, deep-rooting system, and enormous bearing qualities was extensively grown and the taste for it acquired, there would be an enormous demand at remunerative prices, and it probably would become as well known and appreciated in India as it is in Europe and America at the present time.

The lime (*C. medica* var. *acida*) of which there are at least three distinct kinds, *viz.*, thorny, thornless, and seedless. If possible, the thornless variety should be chosen for general cultivation owing to the convenient way in which pruning, gathering the fruit, and general cultivation can be carried out, and this applies especially in India, where the labourers generally work bare-footed. If, however, a thorny variety be planted, the inconvenience of the thorns can, to a great extent, be overcome by careful handling at pruning time, by having some kind of cart, handled between the lines in which all prunings are thrown, and this will probably pay for doing, in view of the fact that, so far as is known at present, the thorny gives the highest percentage of citric acid. There does not appear to be any appreciable difference between the thorny and seedless varieties in this respect.

It is found, where limes are grown on a large scale, that the citric acid content of the juice varies considerably with the rainfall, that is, in a wet climate or season the acid content is low, whereas during dry weather, or where the average rainfall is small, the acid content is high, the variation being from 10 oz. per gallon in the wet weather to 14 oz. in dry weather—tests in the West Indies. In June of this year, after trees growing in Yercaud had passed through a very severe dry weather, the juice tested as high as $21\frac{1}{2}$ oz. per gallon, whereas in December, after a long spell of wet weather, the test gave only 10 oz. to the gallon. At the same time, the variation in such figures may be more apparent than real, as fruit may contain more juice in a wet season than in a dry one, and it is quite possible that, although the percentage of citric acid per gallon may be lower in wet weather, the probable extra amount of juice will compensate, or perhaps more than compensate, for the higher percentage in dry weather fruit. Although the different kinds of lime in general cultivation do not appear to vary greatly either in acid content or the amount of juice per given weight of fruit, this is a point which appears to lend itself to very useful research work, both on the line of natural selection, and possibly through budding selected plants on to vigorous stocks, with a view to improve not only the yield of acid content, but also the improvement in quality and quantity of the essential oil in the rind, and this is a point well worth considering before planting out on a large scale, the main issues being the citric acid percentage, quantity of juice and essential oil obtainable per acre. And I cannot find that, up to the present, this subject has seriously been studied in a scientific manner. It is obvious that one acre of limes giving an average of, say, 2,000 fruits per tree of 10 oz. acid content is more profitable than one giving 200 per tree of the same sized fruit giving 10 oz. acid per gallon.

You will now naturally want to know the possible returns from citrus fruit growing, and this is a point on which I fear much controversy will arise, and to avoid the possibility of misunderstanding which may lead a prospective planter astray and cause him to invest his capital without a full knowledge of the subject,

I will say at once that other things being equal—much, in fact everything, depends on the individual. At the same time, there is no reason why any one interested in fruit culture should go astray when really sound advice can be easily obtained from the Agricultural Department, and—strange as it may seem—I have much more faith in the eagle eye of an entomologist or mycologist than in a painted *chatti* which one sometimes sees erected on a pole to ward off the evil eye. As there is now no excuse for any one going astray on this point, I will give you some figures which may encourage some one to have a flutter at what I consider to be a paying proposition. To begin on the safe side, I cannot, I think, do better than quote figures which I gave to a fruit-planter who obtained my advice some time ago in connection with his orange trees, which consisted chiefly of Mandarines, Washington Navel, Navelia, St. Michael, Mediterranean Sweet, and Lemons; these figures refer to 9-year old trees which were allowed to overbear in the fourth year and suffered, not only in consequence of this but also from neglect of the ordinary practices of cultivation for the remaining five years and they were in anything but good condition. I estimated that given proper cultivation and pruning, each tree should give an average of 5 dozen perfect fruits the same season, which, considering the excellent varieties and the advantageous market conditions, would have sold at 8 annas per dozen or Rs. 2-8-0 per tree, and this on over 700 trees, or roughly 7 acres, or say, Rs. 250 an acre. Allowing Rs. 100 an acre for cultivation, manure, etc., and cost of marketing the crop, it would have left Rs. 150 an acre clear. Had those trees been properly cared for and Rs. 100 an acre spent annually on cultivation, pruning and manure, they would have, at 9-year old, given considerably over 500 fruits per tree, and this is what I consider to be a fair average crop on well-cared-for trees under general Indian conditions for oranges, lemons, citrons, etc. Limes of course bear much heavier crops, and, owing to their being planted 15′ × 15′ apart which would allow them ample room even on the best of soils and give 193 trees per acre, I have seen trees which gave an annual crop of between three and five thousand limes of good size. As to the prices obtainable for fruit in different

districts, much depends on the market facilities on each plantation; it is impossible to give anything like an accurate statement as to possible profits in each district. But the figures I have given will, I think, enable any one interested in the subject to form a fair idea on this point. Unfortunately I am unable to go into details of the manufacture and sale prices, etc., of citric acid in such a short paper as this must be. There are other aspects of citrus culture, such as the preservation of fruit by the sweating process and allied subjects, which, I fear, must be left out of this paper, also through lack of time. As it is, I am afraid I have overstepped the time limit and trust you will excuse the prolonged babbling of an enthusiast.

BRITISH CROP PRODUCTION.*

BY

DR. EDWARD J. RUSSELL, F.R.S.

CROP PRODUCTION in Britain is carried on in the hope of gain, and thus differs fundamentally from gardening, which is commonly practised without regard to profit and loss accounts. Many poets from times of old down to our own days have sung of the pleasures to be derived from gardening. But only once in the history of literature have the pleasures of farming been sung, and that was nearly two thousand years ago.

> Ah ! too fortunate the husbandmen, did they but know it, on whom, far from the clash of arms, earth their most just mistress lavishes from the soil a plenteous subsistence.—"Georgics," Bk. II., i, 458 *et seq.*

"Did they but know it"! Even then there seem to have been worries!

This seeking for profit imposes an important condition on British agriculture : maximum production must be secured at the minimum of cost. This condition is best fulfilled by utilizing to the full all the natural advantages and obviating so far as possible all the natural disadvantages of the farm—in other words, by growing crops specially adapted to the local conditions, and avoiding any not particularly well suited to them.

From the scientific point of view the problem thus becomes a study in adaptation, and we shall find a considerable interplay of factors, inasmuch as both natural conditions and crop can be somewhat altered so as the better to suit each other.

It is not my province to discuss the methods by which plant-breeders alter plants ; it is sufficient to know that this can be done

* Discourse delivered at the Royal Institution in February 1920. Reprinted from *Nature*, dated the 8th April, 1920.

within limits which no one would yet attempt to define. The natural conditions are determined broadly by climate and by soil. The climate may be regarded as uncontrollable. "What can't be cured must be endured." The scheme of crop production must, therefore, be adapted to the climate, and especially to the rainfall.

The rainfall map shows that the eastern half of England is, on the whole, drier than the western half. In agricultural experience, wheat flourishes best in dry conditions and grass in wet conditions; the vegetation maps show that wheat tends to be grown in the eastern and grass in the western part. The strict relationship is that seed production is appropriate to the drier, and leaf production to the wetter, districts.

The great soil belts of England south of the Trent run in a south-westerly direction; north of the Trent, however, they run north and south. A heavy soil, like a wet climate, favours grass production; a light soil, like a dry climate, is suitable for arable crops. The great influence of climate is modified, but not overridden, by the soil factor.

The arable farmer grows three kinds of crops: corn, clover or seeds hay, and fodder crops for his animals or potatoes for human beings. The same general principles underlie all, and as corn crops are of the most general interest (though not necessarily of the greatest importance) they will serve to illustrate all the points it is necessary to bring out. We have seen that wheat is cultivated more in the eastern than in the western portion of the country. The figures for consumption and production are as follows:—

Millions of tons per annum.

	Consumption in United Kingdom	Production in England and Wales			Production in United Kingdom		
		Before war 1914	1918	1919	Before war 1914	1918	1919
Wheat ..	7·40	1·6	2·3	1·8	1·7	2·6	2·0
Barley ..	1·96	1·2	1·2	1·1	1·6	1·5	1·3
Oats ..	4·30	1·4	2·0	1·6	3·0	4·5	4·2

During the war very serious attention was paid to the problem of reducing the gap between consumption and production. A working solution was found by lowering the milling standard, retaining more of the offal, and introducing other cereals and potatoes; a very considerable proportion of the resulting bread was thus produced at home. But the war-bread did not commend itself, and disappeared soon after the armistice; since then the consumption of wheat has gone up, and the divergence between consumption and production has again become marked. There is no hope of reducing consumption; we must, therefore, increase production. Additional production may be obtained in two ways: by increasing the yield per acre, and by increasing the number of acres devoted to the crop.

The yield per acre is shown in the following table:—

Measured bushels per acre.

	(1908-17) Average yield per acre		A good farmer expects	Highest recorded yield
	England and Wales	Scotland		
Wheat ..	31·0	39·9	40 to 50	96
Barley ..	31·9	35·4	40 to 60	80
Oats ..	39·3	38·9	60 to 80	121

Unfortunately the terms "bushel" and "quarter" (8 bushels) lack definiteness, being used officially in three different senses and unofficially in several others also. The following are some of the definitions of a bushel:—

	Official statistics. A definite volume having the following average weight	Corn Returns Act. Volume occupied by following weight	Grain Prices Order. Volume occupied by following weight	Frequent practice. Volume occupied by following weight
	lb.	lb.	lb.	lb.
Wheat ..	61·9	60	63	63
Barley ..	53·7	50	55	56
Oats ..	39·3	39	42	42

The average results include bad farmers and bad seasons; the good farmer expects to do considerably better, but he has many things in his favour: superior knowledge, greater command of capital, and possession of good land; he will, therefore, always stand above the average. Even his results can be improved; the highest recorded yields show what can be done with present varieties and present methods in exceptionally favourable circumstances. The figures give the measure of the scientific problem, which is to discover what changes would be necessary in order to bridge the enormous gap between the average and the best. In three directions progress is possible: we may modify the plant, or the soil, or we may mitigate the effects of unfavourable climate.

Before the soil can be brought into cultivation at all it is necessary to carry out certain major operations—draining, enclosing, etc.,—which have to be maintained in full order. These lie outside our present discussion; we must assume that they are properly carried out, which is by no means always the case. Given adequate drainage, soil conditions are profoundly modified by cultivation, which has developed into a fine art in England and Scotland, and is, indeed, far better practised here than in most other countries. But it is an art, and not yet a science; the husbandman achieves the results, but no one can yet state in exact terms precisely what has happened. A beginning has been made, and a laboratory for the study of soil physics has been instituted at Rothamsted and placed under Mr. B. A. Keen, where we hope gradually to develop a science of cultivation. For the present cultivation remains an art, and, further, it is essentially a modern art. The medieval implements, as shown in the Tiberius MS. (eleventh century) and the Luttrell Psalter (fourteenth century), were crude, and left the ground in an exceedingly rough condition. Great advances were made throughout the nineteenth century. Robert Ransome, of Ipswich, took out his first patent in 1785 to improve the plough; he was followed in 1812 by Howard, of Bedford, and later by Crosskill, Marshall, Rushton, Fowler, and others, who have made British implement makers famous throughout the world. Given time and sufficient labour

the good British farmer using modern implements can accomplish wonders in the way of cultivation.

Unfortunately, neither time nor labour is always available. Ploughing is possible only under certain weather conditions, and there are many days in our winters when it cannot be carried out. Unless, therefore, a large staff of men and horses is kept, the work often cannot be done in time to allow of sowing under the best conditions.

The early days of the life of a plant play almost as important a part in its subsequent history as they do in the case of a child. Illustrations are only too numerous of the adverse effect of being just too late for good soil conditions. One from our own fields is as follows :—

Work completed	Seed sown	Yield of wheat 1916 Bushels per acre
Just in time	Nov. 24, 1915	26·8
Just too late	Feb. 17, 1916	19·3

The farm-horse will not be speeded up, but maintains an even pace of $2\frac{1}{2}$ miles per hour. According to the old ploughman's song still surviving in our villages, an acre a day is the proper rate :—

We've all ploughed an acre, I'll swear and I'll vow,
For we're all jolly fellows that follow the plough.

But under modern conditions it is impossible to get more than three-quarters of an acre a day ploughed on heavy land, and the scarcity of teams threatened to bring arable husbandry into a hopeless *impasse*. Fortunately for agriculture, the internal-combustion engine appeared on the farm at a critical moment in the shape of the tractor, and has brought the promise of a way out. The tractor has two important advantages over the horse. First of all, it works more quickly. Its pace is $3\frac{1}{2}$ miles per hour instead of $2\frac{1}{2}$ miles. It turns three furrows at a time instead of one only; on our land it ploughs an acre in four hours instead of taking nearly a day and a half as required by horses. There is no limit to the work it can do; even an acre an hour is no wild dream,

but may yet be accomplished. It therefore enables the farmer to get well forward with his ploughing during the fine weather in late summer and early autumn, and thus to obtain the great advantages of a partial fallow and of freedom to sow at any desired time. On our own land our experience has been as follows :—

Dates of completion of sowings of wheat and oats.

Year	Wheat	Oats	
1916	February 17 ..	October 16 ..	Horses only.
1917	March 16 ..	„ 17 ..	Horses only.
1918	January 26 ..	„ 27 ..	Horses only.
1919	November 26 ..	„ 5 ..	Tractor.

Further, if the plough is correctly designed and properly used, the tractor does the work fully as well as horses—even the horse-ploughman admits that. It therefore increases considerably the efficiency of the labourer, which, as we shall see later on, might advantageously be raised. The cost of working is apparently less, though it is difficult to decide this until one knows what the repairs bill will be. In our case the cost is :—

Cost of ploughing per acre, Autumn, 1919.

	By tractor	By horses
	s. d.	*s. d.*
Labour	7 7	10 2
Maintenance	——	22 6
Oil and petrol	7 8	——
Depreciation and repairs	6 3	——
	21 6	32 8
Time taken ..	4 hours	$1\frac{1}{2}$ days

The internal-combustion engine is only just at the beginning of its career on the farm, and no one can yet foresee its developments. It is being used at present simply like a horse, and is attached to implements evolved to suit the horse. But it is not a

horse ; its proper purpose is to cause rotation while it is being used to pull, and in some cases, indeed, this pull is reconverted into rotary motion.

The second great method of improving soil conditions is to add manures and fertilizers. Farmyard manure is more effective than any other single substance ; it is likely to remain the most important manure, and if available in sufficient quantity it would generally meet the case. Realizing its importance, Lord Elveden generously provided funds for extended investigations at Rothamsted into the conditions to be observed in making and storing it. This work is still going on, and is leading to some highly important developments.

Farmyard manure, however, is not available in sufficient quantities to meet all requirements. The chemist has long since come to the aid of the farmer ; he has discovered the precise substances needed for the nutrition of the plant, and prepared them on a large scale. Like cultivation, this is largely a British development ; it was in London that the first artificial manure factory was established in 1842, and for many years the industry was centred in this country. The fertilizers now available are as follows :—

Nitrogenous. Nitrate of soda, nitrate of lime, sulphate of ammonia, and cyanamide (nitrolim).

Phosphatic. Superphosphate, basic slag, mineral phosphate, guano, and bones.

Potassic. Sulphate of potash, muriate of potash and kainit.

Agricultural chemists have worked out the proper combinations for particular crops, and obtained many striking results.

Without using any farmyard manure they have maintained, and even increased, the yield of corn crops, fodder crops, and hay ; and in the two latter cases there has been an increase, not only in yield, but also in feeding value per ton. In spite of seventy years' experience there is still much to be learned about the proper use of artificial fertilizers, and they may still bring about even fuller yields from the land.

The yield of corn crops can be increased by artificial fertilizers, but not indefinitely ; the limit is set by the strength of the straw.

As the plant becomes bigger and bigger, so the strain on the straw increases, until finally when the plant is some 5 ft. high, it cannot stand up against the wind, but is blown down.

Little is known about the strength of straw. It is a property inherent in the plant itself, and differs in the different varieties. It is affected by the season, being greater in some years than in others. It is affected also by soil conditions. At present the strength of the straw is the wall against which the agricultural improver is pulled up. The problem can undoubtedly be solved, and the plant-breeder and soil-investigator between them may reasonably hope to find the solution.

Another great effect of artificial fertilizers which has not yet been fully exploited is to mitigate the ill-effects of adverse climatic conditions. Phosphates help to counteract the harmful influence of cold, wet weather; potassic fertilizers help the plant in dry conditions. The combination of a suitable variety with an appropriate scheme of manuring is capable of bringing about considerable improvement in crop production.

A demonstration with the oat crop on these lines was arranged last year in a wet moorland district and the crops when seen in August were as follows:

	Estimated crop Bushels	
Local variety, local treatment	27	Harvest late.
Local variety, phosphatic manuring	45–54	„ earlier.
Special variety "Yielder," phosphatic manuring ..	54–66	„ earlier. stands up well.

The potato crop is governed by the same general principles as corn crops. It furnishes more food per acre than any other crop, but it is much more expensive to produce, and therefore is grown chiefly in districts where the conditions are particularly well suited to it: the Fens, Lincolnshire, the plains of Lancashire, and the Lothians, though smaller quantities are grown in almost every

part of the country. The production and consumption are as follows : —

Potatoes : Annual production and consumption.

Consumption	Production					
	In England and Wales			In United Kingdom		
	Pre-war			Pre-war		
6·5 millions of acres	1914	1918	1919	1914	1918	1919
	3·00	4·20	2·70	7·50	9·20	6·30
	0·46	0·63	0·48	1·20	1·51	1·22

We are thus self-supporting in the matter of potatoes. We do, however, import about half a million tons per annum of early and other potatoes ; we also export seed potatoes and some for food—in all, about one million tons per annum.

(*To be continued.*)

Notes

CONTRIBUTIONS FOR AGRICULTURAL INVESTIGATIONS.

The Trustees of the Sir Sassoon David Trust Fund have made the following grants to the Bombay Department of Agriculture :—

1. A contribution of Rs. 6,666 per annum for three years for the investigation of the insect diseases of *jowar* (*Andropogon Sorghum*) and their methods of control.

2. A contribution of Rs. 5,000 per annum for three years for the investigation of methods of improving poor grazing lands under Deccan conditions.

3. A contribution of Rs. 5,000 per annum for three years for the investigation of the eradication of the most serious weeds of cultivation, and especially of *lavala* (*Cyperus rotundus*).

4. A contribution of Rs. 6,666 per annum for three years for the investigation of drought-resisting, high-yielding varieties of food crops, and especially of *bajri* (*Pennisetum typhoideum*).

5. A contribution of Rs. 2,000 per annum for three years for the study of the deterioration of cardamoms in the spice gardens of Kanara.

6. A contribution of Rs. 3,333 per annum for three years for the study of the economic efficiency of agricultural implements in Western India, and its increase.

7. A contribution of Rs. 5,000 for the investigation of the difficulties of potato cultivation in the Deccan.

8. A contribution of Rs. 10,000 towards the cost of buildings for the rice experimental station at Karjat (Kolaba District, Bombay Presidency).

THE ORIENTATION OF THE BANANA INFLORESCENCE.

THERE has always been a vague belief among banana growers that the orientation of the banana inflorescence is a thing that can be controlled. It was thought that the said inflorescence would appear either on the side of the plant where the cut surface of the corm is found or on the exactly opposite side. No scientific evidence for the belief existed.

The evidence given below tends to show that the inflorescence appears on the side opposite to the cut surface of the corm from which it springs.

In July 1919 the writer superintended the planting of an area of bananas in the Ganeshkhind Botanical Garden. This area measures $1\frac{1}{2}$ acres and contains 550 plants mainly of *Sonkel* and *Rajapuri* varieties. All corms were planted in the same way, namely, with the cut side facing north. It was hoped thus to protect the bunches from the southern sun, if the bunches came out on the north side.

After three or four months all trees showed a slight inclination to the southern side. In the beginning of March 1920 many of the trees of the *Rajapuri* variety began to bear. In every case so far the inflorescence is toward the south.

The inclination of the trees toward the south gave the writer an idea and he hastened to test it by digging out the soil and exposing the roots of a couple of trees. In both the trees examined it was found that the cut surface of the corm had produced no roots, but that the roots were produced along the border of the cut surface. Roots are, however, produced freely from the rest of the corm. This absence of roots from a great portion of one side of the corm means less firm anchoring on that side. As the tree sways with the wind it is conceivable that there is a gradual tendency to bend away from the weakly anchored side. The banana inflorescence, when it appears, will, by the force of gravity, bend over to that side towards which the stem is already leaning.

The number of trees now bearing is 64, and all the inflorescences are bent towards the south. If all the others bend in the

same manner it would seem that there is some ground for the writer's theory, namely, that the bending away from the side of the cut is simply due to imperfect anchoring in the soil.

It is of course possible that this bending, all in one direction, may be due to some factor in the environment. This doubt can be removed by planting the corms so that each row has the cut surface opposite that of the next row. This would bring the inflorescences façing one another in every two rows if the writer's theory is true.

If the theory proves to be true, advantage can be taken of it to plant corms so that the inflorescence and the fruits will not suffer from the sun, or to plant them so that the bunches face one another between the rows and so can be easily watched.—[P. G. DANI.]

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A NOTE ON *HELIOTHIS* (*CHLORIDEA*) *OBSOLETA*, Fb., AS A PEST OF COTTON.

DURING the course of investigation into the bionomics and incidence of *Pectinophora gossypiella* now being carried on at Coimbatore we were surprised to discover *Heliothis obsoleta,* Fb., was engaged in committing more havoc than *Earias fabia, Earias insulana* and *Pectinophora gossypiella* put together. As far as the writer is aware this is the first record of *Heliothis obsoleta* appearing on cotton in pest conditions. In America and in Africa it is a regular pest of cotton, but so far does not appear to have damaged this crop in India.

At the time when most damage was being done, and the damage was considerable, not only was there about 15 acres of Bengal gram (*Cicer arietinum*) on the farm, but next to one of the attacked fields were some tobacco plants in seed. These latter were not touched. The gram crop was almost a total loss. Cambodia cotton appeared to suffer rather more than *Uppam* or *Kurangunni* although the latter varieties were in the next field to the gram field.

The *Heliothis obsoleta* larvæ feed on the young green bolls of the Cambodia both from the outside, according to their usual habit when attacking gram, and also at times entered entirely into

the boll and stayed there until they had eaten the entire contents. At other times a U-shaped tunnel would be driven through the boll. In other cases again the outer rind would be nibbled and then left. In nearly every case where the boll had been entered, a boll attacked meant a boll destroyed, unlike *P. gossypiella* which does not always damage the whole boll. It was observed that before beginning to attack a boll, *H. obsoleta* larvæ would often spin a few threads of silk between the boll and the bracts. At first these threads were attributed to spiders until the time when larvæ were seen at work spinning them.

There is no doubt that if this change of habit (as far as India is concerned) on the part of *H. obsoleta* were persisted in, it would be a far more dangerous pest than either *Earias* or *Pectinophora*.

The attack was first noticed early in January and by the end of February all larvæ had disappeared. A table is given below showing the amount of damage done. This table does not take into account the bolls and buds attacked and fallen to the ground as no trace of these could be kept. The bolls examined did not come from one field but from several fields at different places on the Central Farm.

It may be noted that one consignment of green bolls from Pollachi, distant some 30 miles from Coimbatore, also showed that *H. obsoleta* was present in pest conditions.

No. of bolls examined	Date	Percentage damaged			Remarks
		P.	E.	H.	
* 2,000 ..	10–1–20	45·5	2·50	6·50	6·5% of the bolls destroyed.
2,000 ..	17–1–20	1·1	?	1·80	Increase of flowers and buds.
2,000 ..	24–1–20	0·5	0·65	1·10	
2,000 ..	31–1–20	0·3	0·45	3·75	
2,000 ..	7–2–20	0·4	0·40	3·20	
1,000 ..	14–2–20	0·6	0·60	3·00	
1,000 ..	21–2–20	1·0	2·10	0·50	
1,000 ..	28–2–20	1·2	1·10	nil	

P. —*Pectinophora gossypiella.*
E. —*Earias* sp. *fabia* and *insulana.*
H. —*Heliothis obsoleta.*
* Percentage of H. to E. and to P.

The usual plants attacked by *H. obsoleta* in South India are red gram (*Cajanus indicus*), Bengal gram (*Cicer arietinum*), groundnut (*Arachis hypogœa*), tomato, maize, cholam (*Andropogon Sorghum*), tobacco, *Cannabis sativa,* linseed, safflower, lablab (*Dolichos lablab*).—[E. BALLARD.]

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PLANT HYGIENE.

INCREASING INTEREST is being taken by farmers and commercial fruit and vegetable growers in science as applied to cultivation. Both old established societies—content in the past with their practical knowledge of crop cultivation—and newly formed societies—anxious to base their operations on scientific lines—are asking for lecturers who can demonstrate to them the advantages of the combination of theory and practice. The Ministry welcome such requests, and are endeavouring to meet them as far as possible.

In the middle of January a lecture was delivered in Norwich by Mr. G. C. Gough, B.Sc., an Inspector of the Ministry, on the subject, "Plant Hygiene in Relation to Crops." Mr. Gough first pointed out that *cleanliness* is as important to plants as to human beings, and gave instances of the large losses sustained in this and other countries from the depredations of the pests and diseases of plants and crops.

With regard to measures of control, the lecturer considered the subject under the four headings:—(1) Exclusion, (2) Protection, (3) Eradication, (4) Immunization. Under the first of these he dealt with the necessity of suitable crop rotation, whereby the succession on the same land of crops subject to the same pest was avoided ; the advantages of reasonable separation when planting patches of such crops as bush fruit, in view of the possibility of epidemic outbreaks of disease ; and the need for care in the purchase of seed, bushes or fruit-tree stocks to avoid the introduction of disease. Mr. Gough emphasized the large extent to which nurseries and seed firms are involved in this question, and in pointing out that the grower deserves every assistance to obtain clean and

good material, he foreshadowed the probability of legislation to deal with this aspect of the matter.

Under the heading of *protection*, the lecturer drew attention to the necessity of proper watering and ventilation for crops under glass, and the advantages of spraying and of soil sterilization as an insurance against the attacks of insects, fungi, etc.

It is difficult to draw a line between measures of protection and of eradication, and certain measures included by the lecturer under the latter heading apply equally to the former. Under whatever heading they are included, they constitute some of the most important precepts of plant hygiene, and the danger was emphasized (1) of permitting the rubbish heap to become the manure heap, and thus the breeding place of obnoxious plant pests, and (2) of feeding pigs and other animals on diseased food plants that had not been boiled. The lecturer pointed out that the passage of fungus spores unharmed, through the digestive system of animals, entailed their return to the land under conditions extremely favourable to the vigorous recurrence of disease.

Referring to the question of *pruning*, the lecturer urged its importance from the point of view of the removal of diseased wood, as well as from the purely cultural standpoint, and pointed out that to prune away diseased material without also burning it was but labour in vain. Mr. Gough also spoke at some length on the value of contact and poison insecticides and of the winter washing of fruit trees.

Of all matters relative to plant hygiene, the breeding of varieties immune from disease presents, perhaps, the largest field to the scientific investigator. The lecturer demonstrated by reference to those varieties of potato immune from wart disease that absolute immunity is an established fact; he pointed out the desirability of breeding varieties of crops immune from all the diseases to which they are at present liable, and also of combining this general immunity with good cropping and feeding qualities.

While it would be unwise to lose sight of the necessity of careful drainage, cultivation, manuring, etc., in the raising of healthy crops, attention to the measures outlined by Mr. Gough will be of

increasing benefit to the grower and to the nation.—[*Journal of the Ministry of Agriculture*, March 1920.]

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NEW SOURCE OF ALCOHOL.

MUCH ATTENTION has been given in recent years to the question of manufacturing alcohol within the Empire for use as motor spirit. In Vol. XVII, No. 3 (July–September 1919), of the Bulletin of the Imperial Institute, the possibility of utilizing the *mowra* (*Bassia latifolia*) flowers of India for the purpose is discussed. These flowers possess thick, juicy petals, rich in sugar. They are used by Indians as a foodstuff and especially for the preparation by fermentation of an alcoholic liquor called *daru* or *mohwa* spirit. A single tree will yield as much as 200–300 lb. of flowers in a year. The tree also produces a valuable oil-seed, which is exported in fairly large quantities to Europe. During the war the flowers were used in India for the production of acetone, the yield being said to be ten times as much as that obtained by distilling wood, which is the usual source of this substance. The demand for acetone in India in peace times, however, is not great, and large quantities of the flowers would be available for the manufacture of alcohol, and would appear to be an exceptionally cheap source of this material as the yield is high compared with that from potatoes and other materials commonly used, about 90 gallons of 95 per cent. alcohol being obtainable from one ton of dried flowers. It has been estimated that in the Hyderabad State alone there are already sufficient *mowra* trees for the production of 700,000 gallons of proof spirit per annum, in addition to that necessary for the local liquor requirements.

It is suggested that the most profitable way of utilizing the flowers would probably be as a source of mixed motor spirit of the "natalite" type for use in India. That motor spirit can be produced on a manufacturing scale in India from *mowra* flowers has already been demonstrated, and it is stated that running trials with the spirit proved satisfactory.

SUGAR FROM THE DOUGLAS FIR.

SURPASSING in strangeness any botanical discovery made in recent times is that of a new source of sugar in the leaves of the Douglas fir, which grows in certain confined portions of the dry belt of British Columbia. Professor John Davidson, F.L.S., F.B.S.E., of the University of British Columbia, spent much time in the dry belt region for the purpose of investigating the phenomenon. He found that trees on southern and eastern exposures on gentle slopes in the dry belt region of British Columbia lying between parallels 50 and 51, and longitude 121 to 122, chiefly yielded sugar. The trees which yielded were well apart, thus receiving a good supply of sunlight on their leaves, a more plentiful supply of sunlight on their roots, and having a better air circulation through them than trees in densely forested areas.—[*Production and Export*, April 1920.]

PERSONAL NOTES, APPOINTMENTS AND TRANSFERS, MEETINGS AND CONFERENCES, ETC.

His Majesty the King-Emperor's Birthday Honours List contains the following names which will be of interest to the Agricultural Department :—

C.S.I. Mr. B. P. Standen, C.I.E., I.C.S., Commissioner, Central Provinces and Berar (sometime Director of Agriculture, Central Provinces and Berar).

C.I.E. Mr. C. M. Hutchinson, B.A., Imperial Agricultural Bacteriologist.

Mr. W. C. Renouf, I.C.S., Political Agent, Bahawalpur Agency, Punjab (sometime Director of Agriculture, Punjab).

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Dr. E. J. Butler, M.B., F.L.S., Imperial Mycologist and Joint Director of the Agricultural Research Institute, Pusa, has been appointed substantively *pro tempore* to be Agricultural Adviser to the Government of India and Director of the Agricultural Research Institute, Pusa, with effect from the 1st May, 1920.

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Mr. J. Mackenna, M.A., C.I.E., I.C.S., on leaving Simla to take up his appointment as Development Commissioner in Burma, resigned his appointment as President of the Indian Sugar Committee, with effect from the 26th April, 1920. Mr. F. Noyce, I.C.S., has been appointed to the Presidency of the Committee with effect from the same date.

MR. W. SMITH, Assistant Director of Dairy Farms, Southern Circle, whose services have been placed at the disposal of the Department of Revenue and Agriculture, with effect from the 1st May, 1920, is appointed Imperial Dairy Expert, with effect from the same date, in the Imperial Department of Agriculture in India.

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MR. G. P. HECTOR, M.A., B.Sc., Officiating Imperial Economic Botanist, has been placed, with effect from the 1st May, 1920, in charge of the current duties of the Imperial Mycologist, in addition to his own.

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MR. W. WYNNE SAYER, B.A., has been appointed Supernumerary Agriculturist, with effect from the 20th January, 1919.

***

DR. J. N. SEN, M.A., F.C.S., Supernumerary Agricultural Chemist, has been appointed, with effect from the afternoon of the 30th April, 1920, to act as Imperial Agricultural Chemist during the absence of Dr. W. H. Harrison on leave.

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MR. N. V. JOSHI, B.A., M.Sc., L.AG., First Assistant to the Imperial Agricultural Bacteriologist, has been appointed, with effect from the 11th April, 1920, to act as Assistant Agricultural Bacteriologist, *vice* Mr. J. H. Walton, B.A., appointed to officiate as Imperial Agricultural Bacteriologist.

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MR. A. L. SHEATHER, B.Sc., M.R.C.V.S., Director and First Bacteriologist, Imperial Bacteriological Laboratory, Muktesar, has been granted privilege leave for three months and 24 days from the 17th April, 1920.

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MR. W. A. POOL, M.R.C.V.S., Offg. Second Bacteriologist, has been placed in charge of the current duties of the Director and First Bacteriologist, in addition to his own, during the absence on leave of Mr. A. L. Sheather, with effect from the 17th April, 1920.

MR. A. C. DOBBS has been appointed to be substantively *pro tempore* Director of Agriculture, Bihar & Orissa, with effect from the 6th January, 1920.

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THE services of Mr. G. Clarke, F.I.C., Agricultural Chemist to Government, United Provinces, and Officiating Principal of the Agricultural College, Cawnpore, are placed at the disposal of the Government of India, Department of Revenue and Agriculture, with effect from the date he may be relieved of his present duties.

***

MR. P. K. DEY, who has been appointed by His Majesty's Secretary of State for India to the Indian Agricultural Service, has been appointed to be Plant Pathologist to Government, United Provinces, with effect from the 1st March, 1920.

***

MR. C. H. PARR, who has been appointed by His Majesty's Secretary of State for India to the Indian Agricultural Service, has been appointed to be Deputy Director of Agriculture and to be in charge of cattle-breeding, United Provinces, with effect from the 31st December, 1919.

***

ON the completion of his training at Lyallpur, Malik Sultan Ali has been posted as Deputy Director of Agriculture, 1st Circle, Gurdaspur, with effect from the 6th April, 1920.

***

MR. T. F. QUIRKE, M.R.C.V.S., Officer on special duty in the office of the Chief Superintendent, Civil Veterinary Department, Punjab, took charge of the duties of Officiating Chief Superintendent, Civil Veterinary Department, Punjab, with effect from the afternoon of the 22nd March, 1920, relieving Colonel J. Farmer, C.I.E., F.R.C.V.S., who proceeded on combined leave.

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CAPTAIN K. J. S. DOWLAND, M.R.C.V.S., Professor of Sanitary Science, Punjab Veterinary College, Lahore, assumed

charge of the duties of the Professor of Surgery, in addition to his own, on the afternoon of the 31st March, 1920, from which date Mr. E. Burke, Professor of Surgery, retired from Government service.

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MR. T. M. DOYLE, M.R.C.V.S., has been appointed to the Indian Civil Veterinary Department, with effect from the 21st March, 1920, and is posted to the Government Cattle Farm, Hissar, Punjab.

***

MR. G. MCELLIGOTT, M.R.C.V.S., has been appointed to the Indian Civil Veterinary Department, with effect from the 27th May, 1920, and is posted to Madras as Second Superintendent, Civil Veterinary Department in that Presidency.

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MR. G. F. KEATINGE, C.I.E., I.C.S., on return from leave, has been appointed Director of Agriculture and of Co-operative Societies, Bombay, *vice* Dr. Harold H. Mann placed on special duty in the same office till the date of his departure on leave.

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DR. H. H. MANN is granted, with effect from the date of relief, combined leave for eight months.

***

MR. T. F. MAIN, B.Sc., Deputy Director of Agriculture, Sind, has been allowed, by His Majesty's Secretary of State for India, an extension of furlough for six months.

***

MR. T. GILBERT, B.A., Deputy Director of Agriculture, Southern Division, Bombay Presidency, has been allowed, with effect from the 1st May, 1920, the amount of privilege leave due to him combined with three months' leave on urgent private affairs.

Rao Saheb M. L. Kulkarni has been appointed to act as Deputy Director of Agriculture, Southern Division, Bombay Presidency, during the absence on leave of Mr. T. Gilbert, pending further orders.

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Mr. P. C. Patil, L.Ag., Deputy Director of Agriculture, Central Division, Bombay Presidency, has been allowed an extension by two weeks of the privilege leave granted to him.

***

Mr. K. Hewlett, O.B.E., M.R.C.V.S., has been allowed by His Majesty's Secretary of State for India an extension of commuted furlough for four months.

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On return from leave, Mr. G. Evans, M.A., C.I.E., Deputy Director of Agriculture, Central Provinces, is posted to the Northern Circle.

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Mr. C. P. Maya Das, M.A., B.Sc., Assistant Director of Agriculture, Central Provinces, is confirmed in his appointment, with effect from the 18th May, 1920, but will continue to officiate as Deputy Director of Agriculture, Western Circle, Central Provinces.

***

Mr. R. F. Stirling, who has been appointed by His Majesty's Secretary of State for India to the Indian Civil Veterinary Department and posted to the Central Provinces, assumed charge as Second Superintendent, Civil Veterinary Department, Central Provinces, on the 8th April, 1920.

***

Mr. A. McKerral, M.A., B.Sc., Deputy Director of Agriculture, Burma, has been granted privilege leave for six months, with effect from the 1st June, 1920, or the subsequent date on which he may avail himself of it,

Col. G. H. Evans, C.I.E., C.B.E., M.R.C.V.S., Superintendent, Civil Veterinary Department, Burma, made over and Mr. T. Rennie, M.R.C.V.S., received charge of the duties of Second Superintendent, Civil Veterinary Department, Burma, on the 15th April, 1920. He also made over charge of the office of Third Superintendent to Mr. C. J. N. Cameron on 17th May, 1920.

Reviews

Notes on Improved Methods of Cane Cultivation.—By G. CLARKE, F.I.C., NAIB HUSSAIN and S. C. BANERJEE, Department of Land Records and Agriculture, United Provinces; 1919, pp. 23+10 plates. (Allahabad: Government Press.)

THIS little volume records the results obtained at the Sugarcane Research Station, Shahjahanpur, where a large number of canes have been under trial for several years. The possibilities of intensive cultivation of improved sugarcane, selected to suit local conditions, have been dealt with at some length, and can easily be measured by the average yield of about 100 maunds of *gur* per acre obtained at the station over a number of years, as against 32·6 maunds, the average yield in the United Provinces in 1916-17, from *deshi* canes by the ordinary methods of cultivation. Besides better preparation of the land and the adoption of suitable methods of moisture conservation and soil aeration, the authors advocate the sowing of sugarcane in trenches 2 feet wide and 4 feet from centre to centre as the most suitable for thick and medium canes both as regards germination and yield per acre. To obtain a good crop by these methods of cultivation, manure containing 120 to 150 lb. of nitrogen (equivalent to about 35 to 40 maunds of castor cake) is however required. This is the heaviest item of expenditure involved, but it is definitely stated that a handsome return has always been obtained. The effect of liberally manuring the cane is not confined to that crop alone : the residual nitrogen and the deep cultivation of the trenches effect a striking increase in the yield of wheat or other crops followed by sugarcane, and, to cite an instance, in the harvest of the 1919 *rabi* crop, 36½ maunds per acre of Pusa 12 wheat were obtained over a

field of $3\frac{1}{2}$ acres, with one irrigation only. The preceding crop was Mauritius sugarcane, which yielded 948 maunds per acre or nearly three times the ordinary yield of indigenous varieties.

The intensive methods of cultivation have not, however, been so profitable with the *deshi* canes. Trials have shown that "heavy manuring with nitrogenous manure generally gives rise with *deshi* varieties to excessive vegetative growth without a proportionate formation of sucrose or crystalline cane sugar and, moreover, delays the ripening beyond the time when crushing operations are possible." The potentialities of even the best *deshi* canes in this part of the United Provinces appear to be very limited, but with deeper ploughing, application of small quantities of manure and growing pure races, the outturn can be appreciably increased.

The advantages of using small power mills, in places where central factories do not exist, are also clearly dealt with, and the rotation of crops followed at the Research Station is explained.

There can be no two opinions of the vital interest and importance of the problem of increasing the yield of sugarcane at the present time when the prices of both raw and refined sugar are ruling so high. The world's demand for sugar is continuously increasing, while its production by extension of area is not showing prospects of equal increase. The best solutions of the vexed problem of meeting the increasing demand for it seem, therefore, to lie in increasing the yield per acre by better varieties and intensive methods of cultivation, conducted with scientific skill and care, and by improved processes of manufacture. The United Provinces command about half the total area under sugarcane in British India, and there is a wide scope for introducing the improvements recommended by the authors of this volume, especially as it may now be safely assumed that at no time in the near future is the supply of *gur* or sugar likely to overtake the demand and that high prices are bound to prevail for many years to come, with a correspondingly good margin of profit to the cultivator. The successful adoption of the methods, with regard to improved canes, is, however, dependent on irrigational facilities, capital and intelligent supervision,

and will probably prove beyond the means of the ordinary cultivator; but we hope that the wealthier cultivators and zemindars of the provinces will seriously consider the possibilities and will take the lead in bringing about these improvements which will also ultimately raise the standard of agricultural practice of the country. [EDITOR.]

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Agricultural Statistics of India, 1917-18, VOL. I. Pp. 321+2 maps+9 charts. (Calcutta: Superintendent, Govt. Printing, India.) Price Rs. 2.

THIS annual volume is the thirty-fourth of the series started in 1886 with statistics for 1884-85, and has just been issued by the Department of Statistics, India. It deals with the figures relating to British India only, and, like its preceding issues, is a source of varieties of useful information for all who take an interest in agricultural questions. Statistics are usually stale; nevertheless, a study of this volume will be profitable to many.

The actual area dealt with in this volume is 617,507,000 acres. After allowing for forests, buildings, water, roads, etc., we find that a balance of 387,799,000 acres or 63 per cent. remained available for cultivation, but the net area actually cropped during the year was 227,848,000 acres or 37 per cent. of the total area as against 229,620,000 acres in the preceding year, a decrease of 0·8 per cent. If areas cropped more than once are taken as separate areas for each crop, the gross area cropped in the year amounts to 264,817,000 acres. The area under food grains showed a decrease of 1,336,000 and that under oil-seeds of 527,000 acres as compared with the preceding year. There was an increase of 386,000 acres under sugarcane and of 1,566,000 acres under cotton, attributed chiefly to the stimulus of high prices obtained in the preceding year.

While it is admitted that the Indian figures of area are hard to beat in the matter of accuracy, the same, unfortunately, cannot be said of the figures of average and total yields. The importance of accurate agricultural statistics is, however, fully realized by the Departments of Agriculture and Statistics, and the whole question

received careful consideration of the Board of Agriculture in India held in December 1919, at which the Department of Statistics was represented by its Director. Efforts are being made to arrive at more reliable figures of yields and it may be reasonably expected that, as time goes on, they will become more and more accurate. [EDITOR.]

NEW BOOKS

ON AGRICULTURE AND ALLIED SUBJECTS

1. A Student's Book on Soils and Manures, by Dr. E. J. Russell. Second Edition, revised and enlarged. (The Cambridge Farm Institute Series.) Pp. xii+240. (Cambridge: At the University Press.) Price 6*s.* 6*d.* net.
2. The Fauna of British India, including Ceylon and Burma. Coleoptera. Chrysomelidæ (Hispinæ and Cassidinæ), by Prof. S. Maulik. Pp. xi+439. (London: Taylor and Francis.) Price 1 guinea.
3. Chemical Fertilizers, by S. Hoare Collins. Pp. xii+273. (London: Baillière, Tindall and Cox.) Price 10*s.* 6*d.*
4. Productive Sheep Husbandry, by W. C. Coffey. Pp. x+479. (Philadelphia and London: J. B. Lippincott Company.) Price 10*s.* 6*d.* net; post free, United Kingdom and abroad, 11*s.* 3*d.*
5. Botany for Agricultural Students, by John C. Martin. Pp. x+585. (New York: John Wiley & Sons, Inc.; London: Chapman & Hall, Ltd.) Price 12*s.* 6*d.* net; post free, United Kingdom, 13*s.*; abroad 13*s.* 6*d.*
6. Mining and Manufacture of Fertilizing Materials and their Relation to Soils, by Strauss L. Lloyd. Pp. vi+153. (New York: D. van Nostrand Company; London: Crosby, Lockwood & Son.) Price 9*s.* net; post free, United Kingdom and abroad, 9*s.* 4*d.*
7. Fossil Plants: A Text-book for Students of Botany and Geology, by Prof. A. C. Seward, Vol. IV: Ginkgoales, Coniferales,

Gnetales. (Cambridge Biological Series.) Pp. xiv+543. (Cambridge: At the University Press.) Price 1 guinea net.

8. Bacteriology and Mycology of Foods, by Dr. Fred Wilbur Tanner. Pp. vi+592+10 plates. (New York: John Wiley & Sons, Inc.; London: Chapman and Hall, Ltd.) Price 28*s.* net.
9. Food: Its Composition and Preparation. A Text-book for Classes in Household Science, by Mary T. Dowd and Jean D. Jameson. (The Wiley Technical Series.) Pp. viii+173. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd.) Price 6*s.* net.
10. Chemistry and its Mysteries: The Story of What Things are Made of. Told in Simple Language, by Charles R. Gibson. (Science for Children.) Pp. 246. (London: Seeley, Service Co., Ltd.) Price 4*s.* 6*d.* net.
11. A Manual of Elementary Zoology; by L. A. Borradaile. Third edition. Pp. xviii+616+xxi plates. (London: Henry Frowde and Hodder and Stoughton.) Price 18*s.*
12. Essays on Wheat, by Prof. A. H. R. Buller. Pp. xv+339. (New York: The Macmillan Co.; London: Macmillan & Co., Ltd.) Price 2·50 dollars.

The following publications have been issued by the Imperial Department of Agriculture in India since our last issue:—

1. A Note on the Treatment of Surra in Camels by Intravenous Injections of Tartar Emetic, by H. E. Cross, M.R.C.V.S., D. V. H., A.Sc. (Bulletin No. 95.) Price, As. 2.
2. Motor Tractors at Lincoln Trials, September, 1919. Free.